

EVERYDAY

JULY 1996

PRACTICAL

ELECTRONICS

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FULLY S.O.R. £2.45

THE NET

What's in it for you?

GAMES

COMPENDIUM

*PIC based Dice, Lottery,
Roulette & Bingo*

TWIN-BEAM

IR ALARM

Prevent unauthorised
entry

INGENUITY

UNLIMITED

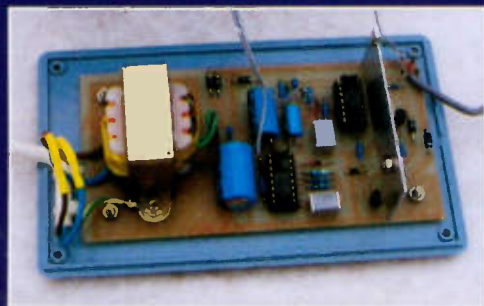
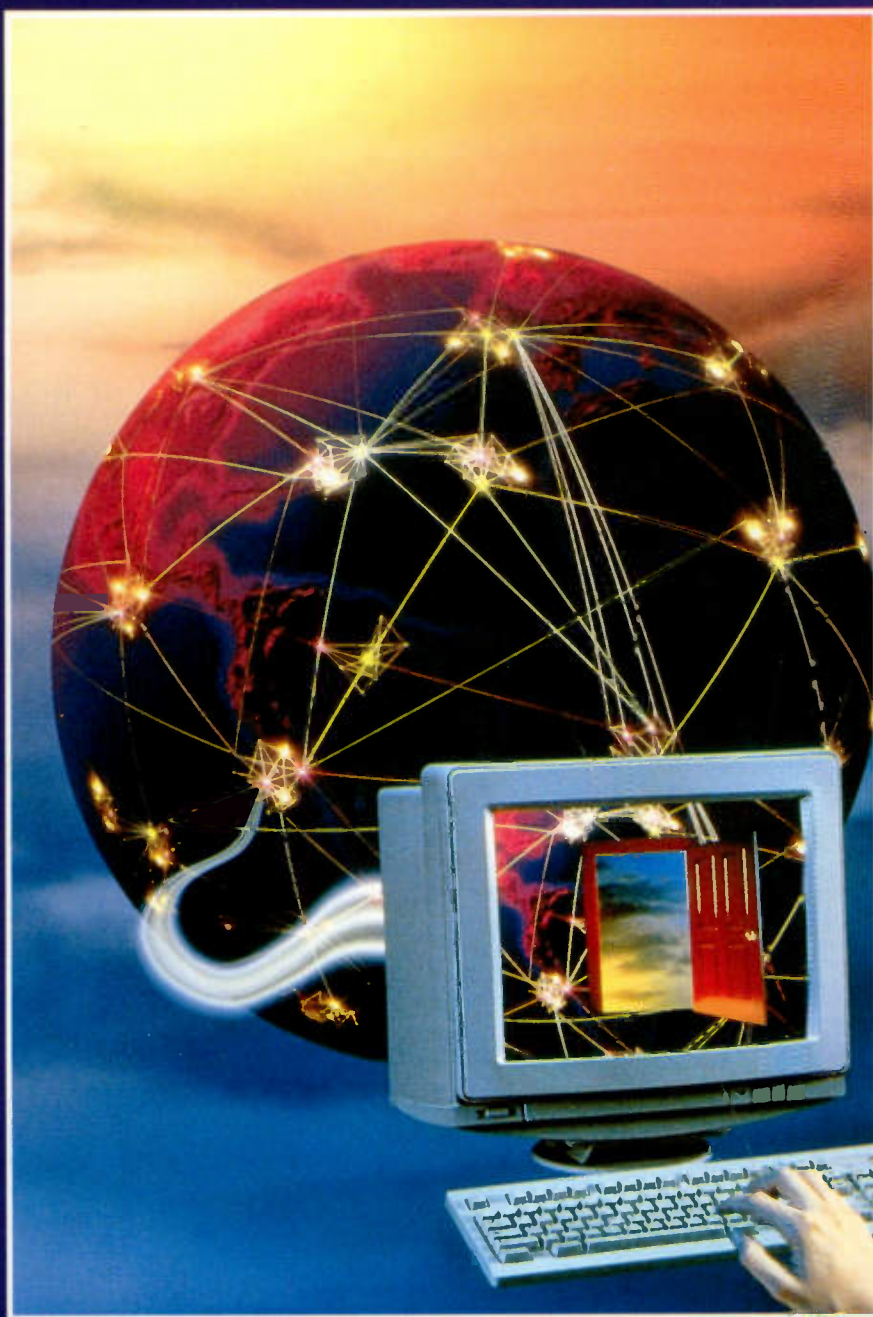
Readers' Circuit Ideas

ADVANCED

NI-CAD

CHARGERS

Take good care of
your batteries



THE No. 1
MAGAZINE FOR
ELECTRONICS TECHNOLOGY
& COMPUTER PROJECTS



SURVEILLANCE TELESCOPE Superb Russian zoom telescope adjustable from 15x to 60x complete with metal tripod (impossible to use without this on the higher settings) 66mm lens, leather carrying case £149 ref BAR69

RADIATION DETECTOR SYSTEM Designed to be wall mounted and connected into a PC, ideal for remote monitoring, whole building coverage etc. Complete with detector, cable and software. £19.95 ref BAR75

WIRELESS VIDEO BUG KIT Transmits video and audio signals from a miniature CCTV camera (included) to any standard television! All the components including a PP3 battery will fit into a cigarette packet with the lens requiring a hole about 3mm diameter. Supplied with telescopic aerial but a piece of wire about 4" long will still give a range of up to 100 metres. A single PP3 will probably give less than 1 hours use. £99 REF EP79. (probably not licensable)

CCTV CAMERA MODULES 46X70X29mm, 30 grams, 12v 100mA, auto electronic shutter, 3.6mm F2 lens, CCIR, 512x492 pixels, video output is 1v p-p (75 ohm) Works directly into a scart or video input on a tv or video. IR sensitive. £79.95 ref EF137

IR LAMP KIT Suitable for the above camera enables the camera to be used in total darkness! £5.99 ref EF138

REMOTE CONTROL TANDATA TD1400 MODEM/VIEWDATA Complete system comprising 1200/75 modem, auto dialler, infra red remote keyboard, (could be adapted for PC use?) psu, UHF and RGB output, phone lead, RS232 output, composite output. Absolute bargain for parts alone! £9.95 ref BAR33

9 WATT CHIEFTAN TANK LASERS

Double beam units designed to fit in the gun barrel of a tank each unit has two semi conductor lasers and motor drive units for alignment 7 mile range full circuit diagrams new price £50 000? us? £349 Each unit has two gallium Arsenide injection lasers 1 x 9 watt 1 x 3 watt 900nm wavelength 28vdc 600hz pulse frequency The units also contain an electronic receiver to detect reflected signals from targets five or more units £299 ea £349 for one Ref LOT4

TWO WAY MIRROR KIT Includes special adhesive film to make two way mirror(s) up to 60"x20". (glass not included) includes full instructions. £12 ref TW1

NEW HIGH POWER RF TRANSMITTERS

AMPLIFIERS Assembled PCB transmitters, 4 types available, 12.6vdc 90 watt 1.5-30mhz 75 ohm in/out FM/AM £75 ref RF1 12.6vdc 40 watt 50-200mhz 50 ohm in/out FM/AM £65 ref RF2 28vdc 125 watt 1.5-30mhz 75 ohm in/out FM/AM £85 ref RF3 28vdc 100 watt 50-200mhz 50 ohm in/out FM/AM £75 ref RF4 A heat sink will be required, nng for price and availability.

If you intend using these as audio transmitters you will need a also need a preamp. Complex module available at £40 ref RF5

COMPUTER/WORKSHOP/HIFI RCB UNITS Complete protection from faulty equipment for everybody! Inline unit fits in standard IEC lead (extends it by 750mm), fitted in less than 10 seconds, reset/test button, 10A rating. £9 each Ref MM5.

RADIO CONTROLLED CARS FROM £6 EACH!!!!

All returns from famous manufacturer, 3 types available, single channel (left, right, forwards, backwards) £6 ref LOT1. Two channel with more features £12 ref LOT2. Two channel proportional (plug in crystals etc) £35 ref LOT3

THOUSANDS AVAILABLE RING/FAX FOR DETAILS!

MAGNETIC CARD READERS (Swipes) £9.95 Cased with flyleads, designed to read standard credit cards! they have 3 wires coming out of the head so they may write as well? complete with control electronics PCB just £9.95 ref BAR31

WANT TO MAKE SOME MONEY? STUCK FOR AN IDEA? We have collated 140 business manuals that give you information on setting up different businesses, you peruse these at your leisure using the text editor on your PC. Also included is the certificate enabling you to reproduce (and sell) the manuals as much as you like! £14 ref EP74

PANORAMIC CAMERA OFFER Takes double width photographs using standard 35mm film. Use in horizontal or vertical mode. Complete with strap £7.99 ref BAR1

COIN OPERATED TIMER KIT Complete with coin slot mechanism, adjustable time delay, relay output, put a coin slot on anything you like! TV's, videos, fridges, drinks cupboards, HIFI, takes 50p's and £1 coins DC operated, price just £7.99 ref BAR27. **ZENITH 900 X MAGNIFICATION MICROSCOPE** Zoom, metal construction, built in light, shmp arm, group viewing screen, lots of accessories. £29 ref ANAYLT.

AA NICAD PACK Pack of 4 tagged AA nicads £2.99 ref BAR34 **PLASMA SCREENS** 222x310mm, no data hence £4.99 ref BAR87

NIGHTSIGHTS Model TZS4 with infra red illuminator, views up to 75 metres in full darkness in infrared mode, 150m range, 45mm lens, 13 deg angle of view, focussing range 1.5m to infinity. 2 AA batteries required. 950g weight. £199 ref BAR61. 1 years warranty

LIQUID CRYSTAL DISPLAYS Bargain prices, 16 character 2 line, 99x24mm £2.99 ref SM1623A 20 character 2 line, 83x19mm £3.99 ref SM2020A 16 character 4 line, 62x25mm £5.99 ref SMC1640A

TAL-1 110MM NEWTONIAN REFLECTOR TELESCOPE Russian Superb astronomical scope, everything you need for some serious star gazing! up to 169x magnification. Send or fax for further details £249 ref TAL-1

GOT AN EXPENSIVE BIKE? You need one of our bottle alarms, they look like a standard water bottle, but open the top, insert a key to activate a motion sensor alarm built inside. Fits all standard bottle camers, supplied with two keys. **SALE PRICE £7.99 REF SA32**

GOT AN EXPENSIVE ANYTHING? You need one of our cased vibration alarms, keyswitch operated, fully cased just to fit it to anything from videos to caravans, provides a years protection from 1

WOLVERHAMPTON BRANCH NOW OPEN AT WORCESTER ST W'HAMPTON TEL 01902 22039

PP3 battery, UK made. **SALE PRICE £4.99 REF SA33.**

DAMAGED ANSWER PHONES These are probably beyond repair so just £4.99 each. BT response 200 machines. REF SA30.

COMPUTER DISC CLEAROUT We are left with a lot of software packs that need clearing so they are selling at disc value only! 50 discs for £4, that's just 8p each! (our choice of discs) £4 ref EP66

IBM PS2 MODEL 160Z CASE AND POWER SUPPLY Complete with fan etc and 200 watt power supply. £9.95 ref EP67 **DELL PC POWER SUPPLIES** 145 watt, +5, -5, +12, -12, 150x150x85mm complete with switch, flyleads and IEC socket. **SALE PRICE £9.99 ref EP55**

1.44 DISC DRIVES Standard PC 3.5" drives but returns so they will need attention **SALE PRICE £4.99 ref EP68**

1.2 DISC DRIVES Standard 5.25" drives but returns so they will need attention **SALE PRICE NOW ONLY £3.50 ref EP69**

PP3 NICADS Unused but some storage marks. £4.99 ref EP52 **DELL PC POWER SUPPLIES** (Customer returns) Standard PC psu's complete with fly leads, case and fan. +12v, -12v, +5v, -5v **SALE PRICE £1.99 EACH** worth it for the bits alone! ref DL1. **TRADE PACK OF 20 £28.95 Ref DL2**

GAS HOBS AND OVENS Brand new gas appliances, perfect for small flats etc. Basic 3 burner hob **SALE PRICE £2.49 ref EP72.** Basic small built in oven **SALE PRICE £7.99 ref EP73**

RED EYE SECURITY PROTECTOR 1,000 watt outdoor PIR switch **SALE PRICE £8.99 ref EP57**

ENERGY BANK KIT 100 6"x6" 6v 100mA panels, 100 diodes, connection details etc. £69.95 ref EF112.

PASTEL ACCOUNTS SOFTWARE, does everything for all sizes of businesses, includes word processor, report writer, windowing, networkable up to 10 stations, multiple cash books etc. 200 page comprehensive manual. 90 days free technical support (0345-326009 try before you buy!) Current retail price is £128, **SALE PRICE £9.95 ref SA12. SAVE £120!!!**

COMPLETE PC 200 WATT UPS SYSTEM Top of the range UPS system providing protection for your computer system and valuable software against mains power fluctuations and cuts. New and boxed. UK made. Provides up to 5 mins running time in the event of complete power failure to allow you to run your system down correctly. **LAST FEW TO CLEAR AT £49 SAVE £30 ref LOT61** **BIG BROTHER PSU** Cased PSU, 6v 2A output, 2m o/p lead, 1.5m input lead, UK made, 220v. **SALE PRICE £4.99 REF EP7**



Check out our
WEB SITE

<http://www.pavilion.co.uk/bull-electrical>

RACAL MODEM BONANZA! 1 Racal MPS 1223 1200/75 modem, telephone lead, mains lead, manual and comms software, the cheapest way onto the net! all this for just £13 ref DEC13.

4.6mw LASER POINTER. BRAND NEW MODEL NOW IN STOCK!, supplied in fully built form (looks like a nice pen) complete with handy pocket clip (which also acts as the on/off switch.) About 60 metres range! Runs on 2 AAA batteries. Produces thin red beam ideal for levels, gun sights, experiments etc. just £39.95 ref DEC49 **TRADE PRICE £28 MIN 10 PIECES**

BULL TENS UNIT Fully built and tested TENS (Transcutaneous Electrical Nerve Stimulation) unit, complete with electrodes and full instructions. TENS is used for the relief of pain etc in up to 70% of sufferers. Drug free pain relief, safe and easy to use, can be used in conjunction with analgesics etc. £49 Ref TEN/1

RUSSIAN MONOCULARS Amazing 20 times magnification, coated lenses, carrying case and shoulder strap £29.95 Ref BAR73 **PC PAL VGA TO TV CONVERTER** Converts a colour TV into a basic VGA screen. Complete with built in psu, lead and s/ware. Ideal for laptops or a cheap upgrade. Supplied in kit form for home assembly. **SALE PRICE £29 REF SA34**

EMERGENCY LIGHTING UNIT Complete unit with 2 double bulb floodlights, built in charger and auto switch. Fully cased, 6v 8AH lead acid req'd. (secondhand) £4 ref MAG4P11.

YUASHA SEALED LEAD AC BATTERIES Two sizes currently available this month. 12v 15AH at £18 ref LOT8 and 6v 10AH (suitable for emergency lights above) at just £6 ref LOT7.

ELECTRIC CAR WINDOW DE-ICERS Complete with cable, plug etc **SALE PRICE JUST £4.99 REF SA28**

AUTO SUNCHARGER 155x300mm solar panel with diode and 3 metre lead fitted with a cigar plug. 12v 2watt. £8.99 REF SA25.

ECLATRON FLASH TUBE As used in police car flashing lights etc, full spec supplied, 60-100 flashes a min. £6.99 REF SA15B.

*SOME OF OUR PRODUCTS MAY BE UNLICESABLE IN THE UK

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24v AC 96WATT Cased power supply. New. £9.99 REF SA40

MICRODRIVE STRIPPERS Small cased tape drives ideal for stripping, lots of useful goodies including a smart case, and lots of components. **SALE PRICE JUST £4.99 FOR FIVE REF SA26**

SOLAR POWER LAB SPECIAL You get TWO 6"x6" 6v 130mA solar cells, 4 LED's, wire, buzzer, switch plus 1 relay or motor Superb value kit **SALE PRICE JUST £4.99 REF SA27**

RGB/CGA/EGA/VTL COLOUR MONITORS 12" in good condition. Back anodised metal case. **SALE PRICE £49 REF SA16B**

PLUG IN ACORN PSU 19v AC 14w £2.99 REF MAG3P10

13.8V 1.9A PSU cased with leads. Just £9.99 REF MAG10P3

UNIVERSAL SPEED CONTROLLER KIT Designed by us for the C5 motor but ok for any 12v motor up to 30A. Complete with PCB etc. A heat sink may be required. £17.00 REF: MAG17

PHONE CABLE AND COMPUTER COMMUNICATIONS

PACK Kit contains 100m of 6 core cable, 100 cable clips, 2 line drivers with RS232 interfaces and all connectors etc. Ideal low cost method of communicating between PCs over a long distance utilizing the serial ports. Complete kit £8.99. Ref comp1

VIEWDATA SYSTEMS made by Phillips, complete with internal 1200/75 modem, keyboard, psu etc RGB and composite outputs, menu driven, autodialler etc. **SALE PRICE £12.99 REF SA18**

AIR RIFLES 22As used by the Chinese army for training purposes, so there is a lot about! £39.95 REF EF78. 500 pellets £4.50 ref EF80

PLUG IN POWER SUPPLY SALE FROM £1.50 Plugs in to 13A socket with output lead, three types available, 9vdc 150mA £1.50 ref SA19, 9vdc 200mA £2.00 ref SA20, 6.5vdc 500mA £2.50 ref SA21

VIDEO BENDER UNIT, Transmits both audio and video signals from either a video camera, video recorder, TV or Computer etc to any standard TV set in a 100' range! (tune TV to a spare channel) 12v DC op. Price is £15 REF: MAG15 12v psu is £5 extra REF: MAG5P2

***MINIATURE RADIO TRANSCEIVERS** A pair of walkie talkies with a range up to 2km in open country. Units measure 22x52x155mm Including cases and ear/pieces. 2xPP3 req'd. £30.00 pr REF: MAG30

***FM TRANSMITTER KIT** housed in a standard working 13A adapter! the bug runs directly off the mains so lasts forever why pay £700? or price is £15 REF: EF62 (kit) Transmits to any FM radio

***FM BUG BUILT AND TESTED** superior design to kit. Supplied to detective agencies. 9v battery req'd. £14 REF: MAG14

TALKING COINBOX STRIPPER COMPLETE WITH COIN SLOT MECHANISMS originally made to retail at £79 each, these units are designed to convert an ordinary phone into a payphone. The units have the locks missing and sometimes broken hinges. However they can be adapted for their original use or used for something else? **SALE PRICE JUST £2.50 REF SA23**

GAT AIR PISTOL PACK Complete with pistol, darts and pellets £12.95 Ref EF82B extra pellets (500) £4.50 ref EF80

6"x12" AMORPHOUS SOLAR PANEL 12v 155x310mm 130mA. **SALE PRICE £4.99 REF SA24**

FIBRE OPTIC CABLE BUMPER PACK 10 metres for £4.99 ref MAG5P13 ideal for experimenters! 30m for £12.99 ref MAG13P1

MIXED GOODIES BOX OF
MIXED COMPONENTS WEIGHING 2 KILOS
YOURS FOR JUST £6.99

4X28 TELESCOPIC SIGHTS Suitable for all air rifles, ground lenses, good light gathering properties. £19.95 ref R/7

RATTLE BACKS interesting things these, small piece of solid perspex like material that it you try to spin it on the desk it only spins one way in fact if you spin it the 'wrong' way it stops of its own accord and go's back the other way! £1.99 ref GIJ01

GYROSCOPES Remember these? well we have found a company that still manufactures these popular scientific toys, perfect gift or for educational use etc. £6 ref EP70

HYPOTHERMIA SPACE BLANKET 215x150cm aluminised foil blanket, reflects more than 90% of body heat. Also suitable for the construction of two way mirrors! £3.99 each ref O/L041

LENSTATIC RANGER COMPASS Oil filled capsule, strong metal case, large luminous points. Sight line with magnifying viewer. 50mm dia, 86gm. £10.99 ref O/K604

RECHARGE ORDINARY BATTERIES UP TO 10 TIMES! With the Battery Wizard! Uses the latest pulse wave charge system to charge all popular brands of ordinary batteries AAA, AA, C, D, four at a time! Led system shows when batteries are charged, automatically rejects unsuitable cells, complete with mains adaptor. BS approved Price is £21.95 ref EP31.

TALKING WATCH Yes, it actually tells you the time at the press of a button. Also features a voice alarm that wakes you up and tells you what the time is! Lithium cell included. £7.99 ref EP26

PHOTOGRAPHIC RADAR TRAPS CAN COST YOU YOUR LICENCE! The new multiband 2000 radar detector can prevent even the most responsible of drivers from losing their licence! Adjustable audible alarm with 8 flashing leds gives instant warning of radar zones. Detects X, K, and Ka bands, 3 mile range, 'over the hill' 'around bends' and 'rear trap' facilities. micro size just 4.25"x2.5"x.75". Can pay for itself in just one day! £79.95 ref EP3

SANYO NICAD PACKS 120mmx14mm 4.8v 270 mA h suitable for cordless phones etc. Pack of 2 just £5 ref EP78

3" DISCS As used on older Amstrad machines, Spectrum plus 3's etc £3 each ref BAR400.

STEREO MICROSCOPES BACK IN STOCK Russian 200x complete with lenses, lights, filters etc etc very comprehensive microscope that would normally be around the £700 mark, our price is just £299 (full money back guarantee) full details in catalogue Ref 95300.

WE BUY SURPLUS STOCK FOR CASH

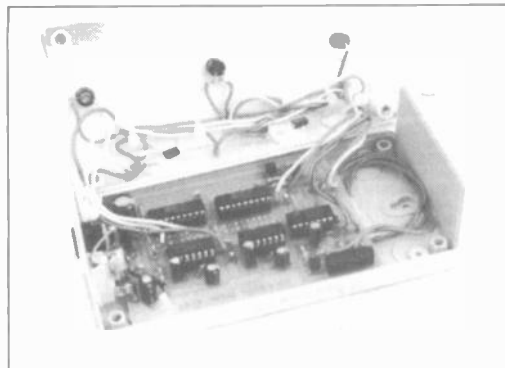
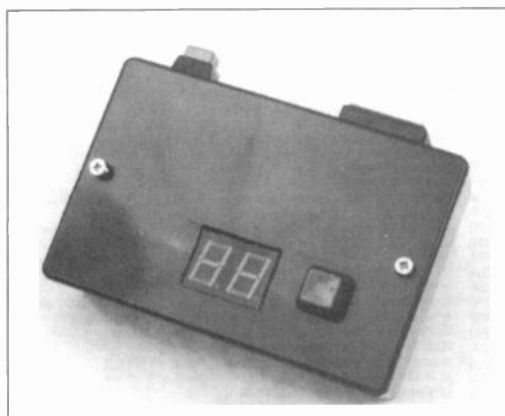
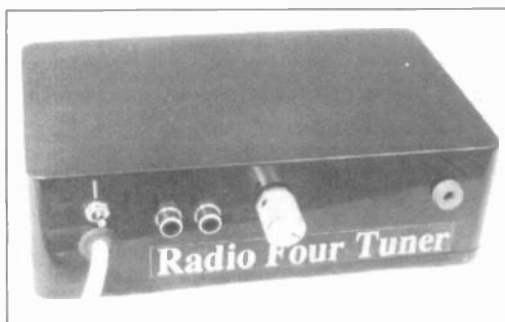
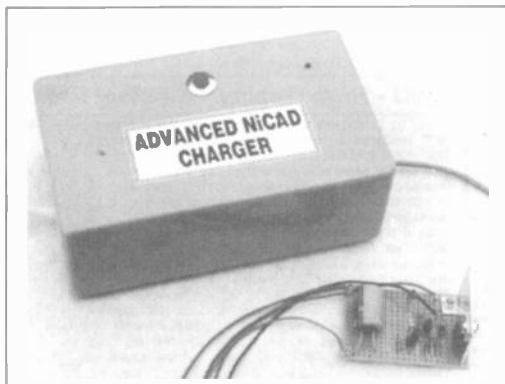
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Our August '96 Issue will be published on Friday, 5 July 1996. See page 491 for details.

Everyday Practical Electronics, July 1996

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Two ways to look after your cells and let the pounds take care of themselves
- SINGLE-STATION RADIO 4 TUNER** by John Linsley Hood **520**
No need to be stumped when the Beeb bats over to LW, now it can be cricket, lovely cricket, at the flick of a switch
- TWIN-BEAM INFRA-RED ALARM** by Max Horsey **534**
If one is too many and two is better than one, what's the logical answer? This dual-security enhancer and no intruders!
- GAMES COMPENDIUM** by John C. Barker **544**
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THE ORIGINAL SURPLUS WONDERLAND!

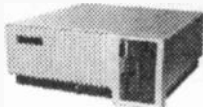
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Surplus always
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SPECIAL BUY AT 286

40Mb HD + 3Mb Ram



LIMITED QUANTITY only of these 12MHz HI GRADE 286 systems Made in the USA to an industrial specification, the system was designed for total reliability. The compact case houses the motherboard, PSU and EGA video card with single 5 1/4" 1.2 Mb floppy disk drive & integral 40Mb hard disk drive to the front. Real time clock with battery backup is provided as standard. Supplied in good used condition complete with enhanced keyboard, 640k + 2Mb RAM, DOS 4.01 and 90 DAY Full Guarantee. Ready to Run!
Order as HIGRADE 286 **ONLY £129.00 (E)**

Optional Fitted extras: VGA graphics card £29.00
1.4Mb 3 1/2" floppy disk drive (instead of 1.2 Mb) £19.95
NE2000 Ethernet (thick, thin or twisted) network card £39.00

LOW COST 486DX-33 SYSTEM

Limited quantity of this 2nd year, superb small size desktop unit. Fully featured with standard simm connectors 30 & 72 pin. Supplied with keyboard, 4 Mb of RAM, SVGA monitor output, 256k cache and integral 120 Mb IDE drive with single 1.44 Mb 3.5" floppy disk drive. Fully tested and guaranteed.
Many other options available - call for details. **Only £399.00 (E)**

FLOPPY DISK DRIVES 3 1/2" - 8"

5 1/4" or 3 1/2" from only £18.95!

Massive purchases of standard 5 1/4" and 3 1/2" drives enables us to present prime product at industry beating low prices! All units (unless stated) are BRAND NEW or removed from often brand new equipment and are fully tested, aligned and shipped to you with a 90 day guarantee and operate from standard voltages and are of standard size. All are IBM-PC compatible (if 3 1/2" supported on your PC).

3 1/2" Panasonic JU363/4 720K or equivalent RFE	£24.95(B)
3 1/2" Mitsubishi MF355C-L 1.4 Meg. Laptops only	£25.95(B)
3 1/2" Mitsubishi MF355C-D 1.4 Meg. Non laptop	£18.95(B)
5 1/4" Teac FD-55FGR 1.2 Meg (for IBM pc's) RFE	£18.95(B)
5 1/4" Teac FD-55F-03-U 720K 40/80 (for BBC's etc) RFE	£22.95(B)
5 1/4" BRAND NEW Mitsubishi MF501B 360K	£22.95(B)
Table top case with integral PSU for HH 5 1/4" Floppy or HD	£29.95(B)
8" Shugart 800/801 8" SS refurbished & tested	£195.00(E)
8" Shugart 810 8" SS HH Brand New	£195.00(E)
8" Shugart 810 8" double sided refurbished & tested	£275.00(E)
Mitsubishi M2894-63 8" double sided NEW	£285.00(E)
Mitsubishi M2896-63-02U 8" DS slimline NEW	£249.00(E)
Dual 8" cased drives with integral power supply 2 Mb	

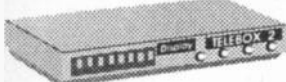
HARD DISK DRIVES

End of line purchase scoop! Brand new NEC D2246 8" 85 Mbyte drive with industry standard SMD interface. Ultra Hi speed data transfer and access times, replaces Fujitsu equivalent model. Complete with full manual. **Only £299.00 or 2 for £525.00 (E)**

3 1/2" FUJII FK-309-26 20mb MFM I/F RFE	£59.95(C)
3 1/2" CONNER CP3024 20 mb IDE I/F (or equiv) RFE	£59.95(C)
3 1/2" CONNER CP3044 40mb IDE I/F (or equiv) RFE	£69.00(C)
3 1/2" RODIME R03057S 45mb SCSI I/F (Mac & Acorn)	£99.00(C)
3 1/2" WESTERN DIGITAL 850mb IDE I/F Brand New	£185.00(C)
5 1/4" MINISCRIBE 3425 20mb MFM I/F (or equiv) RFE	£49.95(C)
5 1/4" SEAGATE ST-238R 30 mb RLL I/F Refurb	£69.95(C)
5 1/4" CDC 94205-51 40mb HH MFM I/F RFE tested	£69.95(C)
8" FUJITSU M3222K 160mb SMD I/F RFE tested	£195.00(E)
Hard disc controllers for MFM, IDE, SCSI, RLL etc. from £18.95	

THE AMAZING TELEBOX

Converts your colour monitor into a QUALITY COLOUR TV!!



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CABLE COMPATIBLE*

The TELEBOX is an attractive fully cased mains powered unit, containing all electronics ready to plug into a host of video monitors made by makers such as MICROVITEC, ATARI, SANYO, SONY, COMMODORE, PHILIPS, TUNING, AMSTRAD etc. The composite video output will plug directly into most video recorders, allowing reception of TV channels not normally receivable on most television receivers* (TELEBOX MB). Push button controls on the front panel allow reception of 8 fully tuneable 'off air' UHF colour television channels. TELEBOX MB covers virtually all television frequencies VHF and UHF including the HYPERBAND as used by most cable TV operators. A composite video output is located on the rear panel for direct connection to most makes of monitor or desktop computer video systems. For complete compatibility - even for monitors without sound - an integral 4 watt audio amplifier and low level Hi Fi audio output are provided as standard.

TELEBOX ST for composite video input type monitors	£36.95
TELEBOX ST as ST but fitted with integral speaker	£39.50
TELEBOX MB Multiband VHF/UHF/Cable/Hyperband tuner	£69.95
For overseas PAL versions state 5.5 or 6 mHz sound specification.	
*For cable / hyperband reception Telebox MB should be connected to a cable type service. Shipping code on all Teleboxes is (B)	

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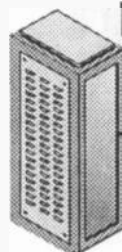
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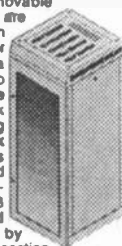


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LIES & ELECTRONICS

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MOLE-ESTER

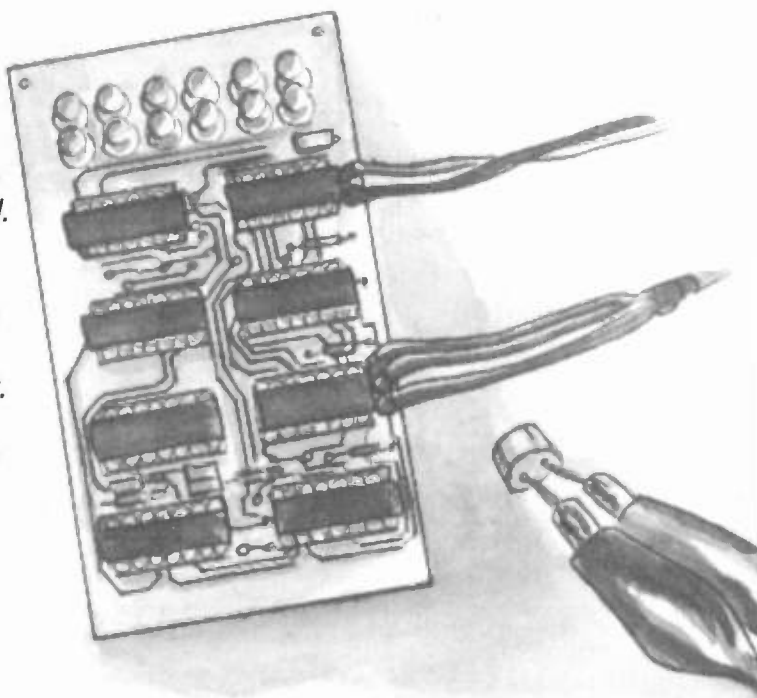
On your bike Mr Mole! An easy to build project for those with lumps in their lawn. The Mole-Ester is a humane, "green" and totally safe way of purging

your garden of malingering moles. A period of use should banish your grief-stricken guests and you can get on with gardening without a constant reminder of their unwelcome visits.

COMPONENT ANALYSER

Although unusual this project will be useful for everyone who is interested in constructing and repairing electronic devices. To put it simply, the Component Analyser will provide information on any bipolar transistor, diode or l.e.d. In addition to this it is capable of producing test tones for loud – speakers and also able to check for simple open or short circuits – fuses, for example, can be verified.

The most surprising ability of this project, is the fact that it will automatically identify all the leads of a transistor without you having to know which pins are which first. For example, you can connect a transistor to the Analyser any way round, the unit will tell you which lead is which, the transistor type (npn/npn) and verify that the transistor is operational. It is also simple to build and inexpensive.



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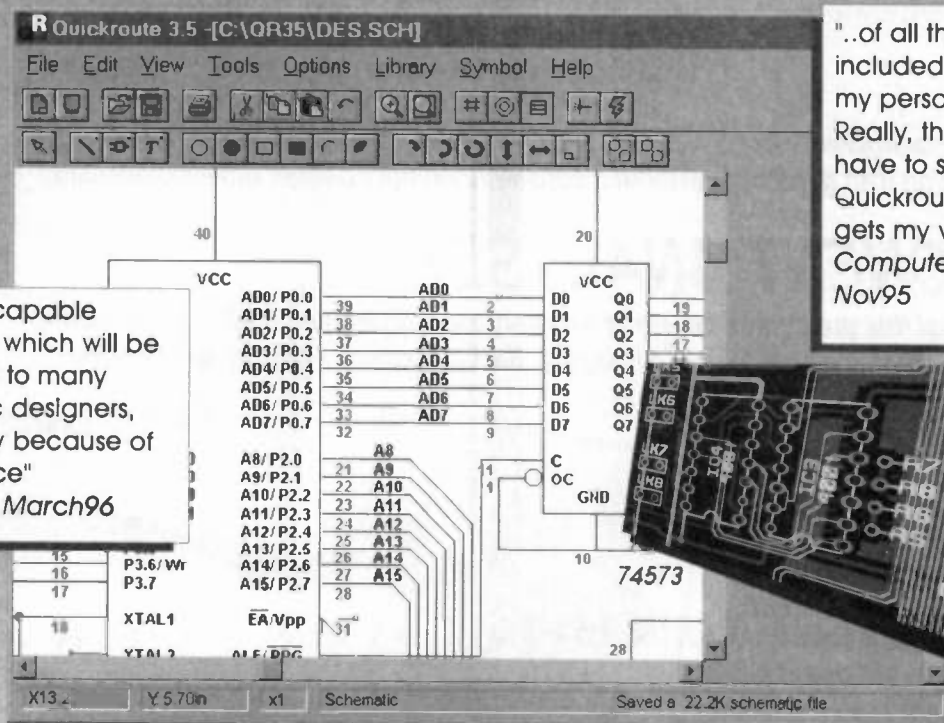
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3 Good Reasons..



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Computer Shopper
Nov 95

..to choose Quickroute 3.5 Designer (apart from the price £149*)

1 Schematic Capture

Creating schematics is easy in Quickroute 3.5 Designer for Windows. Simply select the symbols you require from the libraries and connect the pins using nets. Junctions are automatically placed for you, and correct connections are indicated visually to ensure accurate schematics. Once you are finished just click on the schematic capture button to turn your schematic into a PCB rats-nest.

2 Assisted PCB Routing **NEW**

Quickroute 3.5 Designer is capable of manual PCB routing or assisted routing using Quickroute's built in RouteASSIST technology. To use this simply click on a start and finish node, and RouteASSIST does the rest. Alternatively, you can route manually with rats automatically removed using the 'rat-check' feature.

3 Design Checks

Quickroute 3.5 Designer also includes both design rule checking (DRC) and a simple connectivity check. The connectivity check compares your PCB with the original schematic and gives a pass/fail if there are any differences.

Quickroute 3.5 Designer costs just £149.00. Post & packing is £5 (UK), £8 (Europe) and £12 (Worldwide). *V.A.T must be added to the total price. Quickroute 3.5 is also available in two more powerful versions: PRO (£249) and PRO+ (£399). Contact Quickroute Systems Ltd for full details and a brochure or visit our WWW site and download a free demo.



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Volume and Balance controls are provided and as befits any unit with serious aspirations to quality these are the ultra high quality Alps "Blue Velvet" components.

Very easily built, even by beginners, since all components fit directly on the single printed circuit board and there is no conventional wiring whatsoever. The kit has very detailed instructions, and even comes with a roll of Hart audiograde silver solder. It can also be supplied factory assembled and tested.

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Our 200 page 1996 Catalogue is £2.00, but will be sent free with any order.

First time of advertising for all these products - order soon before stocks are sold!

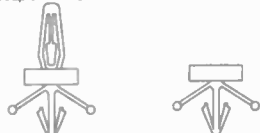
One off and pack prices in bold include VAT: qty prices don't. Number in brackets after order code is approx qty available. P&P £3.00 per order. Pay by cheque, PO, Cash, Book tokens, Visa, Access or Switch We are open for callers from 8-5 30 Mon-Sat.



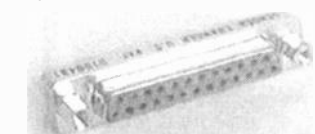
EX4168 (30) Tadran high energy 6.8V lithium battery, housed in a white plastic case 58x39x20mm with a velcro pad on the base. Connection by means of twisted flex terminated in SL plug £4.00

EX6890 (80) A qty of VGA boards. Unfortunately, they've had the edge connector removed, so are being sold for the component value only. Lots of useful surface mount stuff including memory. There are four different types, all in smallish quantities. As they come, £2 each.

A couple of PCB stand-offs



EX6884 (33) 7mm Clip both sides 100/£2.00
EX6885 (34) 7mm, but clip on one side only 100/£1.50

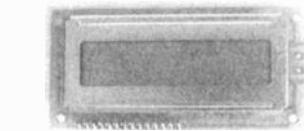


EX4167 (700) Gender changer. Excellent price on this low profile female-female gold plated 25 way device. List around £4. Our Price £1.50; 100+ 0.75

A couple of DRAM modules:



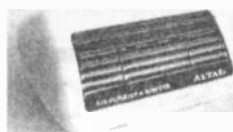
EX4171 (40) 30 pin 256k SIMM 3 chip device - 2 x M514258A-1 and a M51C256 £2.00
EX4172 (70) 30 pin 256k SIMM 9 chip device, MM2801JOS-08 £2.00



EX4170 (300) 16x2 ex-equip LCD module with 0.1" pin connector. Size 84x44 (display 61x16) List £30+ Our Price £4.00; 100+ 2.00



EX4169 (150) In line push to make switch with 18mm screened lead. High quality brass casing £2.00; 100+ 1.20



EX6889 (40) Air purifier and ionizer for in-car use. 12V 18W, covers area of 150 sq ft. Fitted with car power plug. Double sided adhesive pad included £4.00



EX6888 (250) In-ear yellow stereo earphones for use with walkman's etc 32R, FR 12-24000Hz 11m lead £1.00

EX6887 (600) Vero Easwre Great prototyping board originally selling at £15. Another good idea that didn't really take off! Last few hundred of these (we originally had about 20,000) at just £2.50



EX6753 (280) Enhancement cellular aerial. Housed in black plastic with two suckers to attach to window, with 1.7m lead terminated in TNC plug £3.00; 100+ 1.75



EX3938 (50) 32mm female blade connectors. Strip of 100 £2.00



EX3942 (100) Switched mains inlet, as used in portable radios etc 2/£1.00

EX3944 (50) IDC 60 way skt £1.00

EX6806 (500) Klippon 10 way 46" PCB mntg (5mm pitch) terminal block rated 150V 10A. Great Price - 3/£1.00; 100+ 0.18



EX6904 (180) 1m long lead 37D plug one end, 36 way centronics plug the other £3



EX9107 (108) A most excellent Panasonic 15" monitor chassis (no case supplied) - model H15621NA. This has a 15" 110" P31 short persistence green non glare tube and TTL input. The scanning frequency is 15.75kHz, and the bandwidth is 25MHz. Resolution at centre is typically 1300 lines. The power supply is switch mode and will take inputs from 90-264V ac. Supplied with circuit diagram and data sheet £30.00

Graphics Tablet



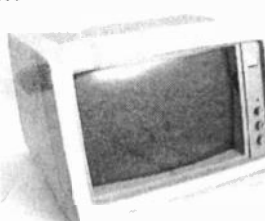
EX9102 (21) Hurta IS/ONE 12x12" input system. Removed from working installation they are complete, but without accessories. Inputs on rear for pen/cursor and interface (both on 8 pin min skts) £20.00



EX9106 (18) IBM PS2 computer. Although the cases are a bit scruffy, some physically damaged, the contents look OK. 286 motherboard with 640k base memory, 90W SMPSU, 1.44Mb 3.5" disk drive and 30Mb hard disk £20.00



EX9100 (48) External mains powered 5.25" disk drive IBM model 4889. Cream case 406x225x63mm. Although the disk drive is a bit old hat, it's an attractive case and useful SMPSU £5.00
EX9101 (60) As above but disk drive missing. £4.00



EX9105 (35) For use with X9106 computers, these are IBM model 5154 EGA 14" colour monitors, not new but in good working order. Identical to those offered in July 1994 still at the same price! £50.00

A Parcel of Tandon Peripherals



EX6896 (20) Notebook fax/data 9600 baud modem model 8009. Complete with handbooks, lead and 2 x 3.5" disks. £15



Some microprocessor modules:

EX6900 (22) Model TH2021 286/16 CPU module £8

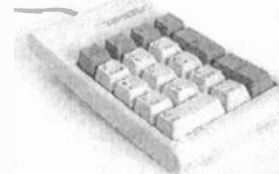
EX6901 (12) Model TH2036 386SLC/60 CPU module £15

EX6902 (11) Model TH2013 386DX/33 32 bit CPU module £15

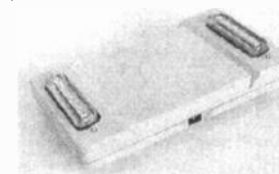
EX6903 (21) Model TH2027 386SX/25 CPU module £15



EX6894 (141) Mono graphic adaptor MGC5143 offers two graphics pages, each 720x348. Half length card, with handbook £5



EX6906 (38) Laptop numeric keypad TM4003 17 keys £5



EX6906 (50) Adaptor 2 x 36 way centronics plugs to 1 skt £3

Loads more bargains in our monthly lists only available to Subscribers - Become one today!

For just £12 a year, you'll receive a new mailing every month full of our latest surplus bargains + reply paid envelopes + Free to enter £25 prize draw every month + 5% discount on most items (new and surplus) + lower postage rates! Can you afford not to subscribe?

Another collection of valves. All are boxed, but a few are not new

Valve Type	Qty	Price
12BA6	1	£3.00
150C2/OA2	1	£4.00
3546	1	£5.50
5654	2	£3.00
5670	3	£5.50
5673	1	£5.50
5763	3	£7.50
5R4GYA	8	£5.00
5R4GYB	1	£5.00
5U4GB	3	£7.00
5Z4	2	£4.00
6136	2	£2.00
6146	2	£7.00
6146A	2	£7.50
6146B	2	£8.00
6201	14	£6.50
6AB7	3	£3.00
6AK6	7	£2.00
6AL5/CV4007	11	£2.00
6AS6	2	£2.00
6BF5	4	£7.00
6BH6	16	£3.00
6BU6	8	£2.00
6DC6	5	£4.00
6DJ8	4	£3.00
6DO5	2	£9.00
6EA8	17	£6.00
6J7	3	£3.00
6L6GA	4	£6.00
6L6GC	17	£6.00
6SG7	8	£4.50
6SL7GT	3	£5.00
6U8A	7	£3.00
6V8	4	£4.00
6V6GT/A	8	£4.00
6V6GT/G	5	£6.00
6X5GT	4	£2.00
7543	2	£8.00
85A2	5	£6.00
A2293	6	£6.00
CV1832/OA2	3	£4.00
CV4014/M8083	20	£3.00
DY51	2	£2.00
E182CC	1	£8.00
E80CC	2	£20.00
E80L	4	£35.00
E88CC	1	£6.00
EAA91	5	£3.00
EB91	2	£1.50
EBC90	2	£1.60
ECC802S	1	£20.00
ECC81	11	£3.00
ECC82	35	£3.00
ECC83	25	£3.00
ECC85	22	£3.00
ECC88	12	£4.00
ECC91	11	£2.00
ECF82	8	£2.00
ECH81	6	£3.00
ECL80	4	£1.50
ECL86	4	£3.00
EF183	9	£1.50
EF184	27	£1.50
EF37A	1	£3.00
EF804	1	£12.00
EF804S	1	£35.00
EF805	1	£8.00
EF805S	1	£8.00
EF84	2	£3.00
EF85	6	£1.50
EF86	20	£4.50
EF91/CV138	14	£1.50
EF93/6BA6	21	£1.50
EL4401	1	£6.00
EL509	3	£5.00
EL83	10	£6.00
EL84	1	£4.00
EL90	3	£2.00
EL96	24	£2.00
MB223	1	£4.00
OB2	1	£2.00
PCF200	2	£2.00
PCF201	5	£2.00
PCF80	4	£1.50
PCF802	3	£1.50
PCF200	3	£2.00
PCL82	1	£2.00
PCL82ST	3	£2.00
PCL84	3	£1.50
PCL85	1	£4.00
PCL86	2	£2.00
PE06-40N	33	£4.00
PL504	4	£3.00
PL509	4	£6.00
PL83	3	£1.50
PL84	1	£1.50
Py81	2	£1.50
Py83	1	£1.50
Py88	3	£1.50
QOE6/40	1	£30.00
QOE03/12/6360	2	£12.00
QOE06/40	1	£30.00
QOV06-40	3	£24.00
QV06/20	3	£20.00
UL84	1	£2.00

£1 BARGAIN PACKS

— List 3

1,000 items appear in our Bargain Packs List — request one when you next order. One item only per pack unless otherwise stated.

SOLAR CELL, will give 100mA of free electricity. Order Ref: 631.
PLASTIC FAN BLADES, 3" diameter, push on spindle, pack of two. Order Ref: 638.
PC GAMES in cases for remaking, pack of six. Order Ref: 645.
PIEZO NOISE MAKERS, standard size, pack of two. Order Ref: 647.
DITTO but mini, only 23mm across. pack of two. Order Ref: 648.
COVERS, suit Piezo sounders, etc, need 22mm hole, pack of six. Order Ref: 651.
10A MICROSWITCHES with screw terminals, mains voltage, pack of two. Order Ref: 662.
PCB MOUNTED RELAY, 5/6V coil, two changeover 5A contacts. Order Ref: 665.
CONTROLLED 4-ROCKER SWITCH, three switches cannot be on unless the first master is on, suit 3kW blow heater, etc. Order Ref: 666.
0.33µF 1000V CAPS, ideal to put in series with 115V 2-4W motors, pack of four. Order Ref: 672.
COPPER CLAD PANEL, size 12" x 9" approximately, make your own PCB or its strong enough to act as a chassis. Order Ref: 683.
100M COIL OF CONNECTING WIRE. Order Ref: 685.
12V MOTOR, extra efficient, will work with solar cells. Order Ref: 687.
SUB MIN PUSH SWITCHES, pack of two. Order Ref: 688.
CERAMIC BEADS, ideal insulation where heat or flame, pack of 100. Order Ref: 690.
6" LENGTHS OF 1/4" DIAMETER PAX TUBING, make useful test prods, etc, pack of three. Order Ref: 691.
PCB PANEL, part of micro TV, has EHT generator circuit. Order Ref: 692.
1920 VINTAGE RESISTORS, you've probably never seen any quite like these, pack of two. Order Ref: 695.
440V A.C. CAP, 4µF, aluminium cased. Order Ref: 702.
POWER SUPPLY UNIT, output 9V 100mA D.C.. Order Ref: 733.
FOLD-OVER TYPE TELESCOPIC AERIAL. Order Ref: 747.
AM/FM TUNING CAPACITOR, air spaced with 1/4" spindle. Order Ref: 743.
MULTI-VOLTAGE TRANSFORMER, gives 10V, 9V, 8V, 7V, 1 1/2V or 1V. Order Ref: 744.
D.P. D.T. ROCKER SWITCHES for motor reversing, etc, pack of two. Order Ref: 745.
BLACK NOISE TRANSPARENT SPEAKER MESH 12" x 9", pack of four. Order Ref: 746.
LIGHTEST TOUCH CHANGEOVER MICROSWITCHES, mains voltage, pack of two. Order Ref: 748.
PAIR PORCELAIN INSULATORS, pack of four, suitable cabin aenals, etc. Order Ref: 749.
CASED PSU, A.C. output, 15V 150mA and 9.8V 60mA. Order Ref: 751.
3-CHANGEOVER CONTACT RELAY with coil, suitable for 12V A.C. or 6V D.C.. Order Ref: 753.
LEVER-OPERATED MICROSWITCHES, ex-equipment, batch tested, any fault would be replaced, pack of ten. Order Ref: 755.
PROJECT BOX, size approximately 100mm x 75mm x 24mm, its lid is a metal heatsink. Order Ref: 759.
EX-BT INSTRUMENT in plastic case with carrying handle, has many useful parts. Order Ref: 760.
PICK-UP ARM with diamond stylus, new and unused. Order Ref: 764.
RUBBER FEET, fit corners of square chassis, pack of 20. Order Ref: 769.
24V BAKELITE ENCASED A.C. OR D.C. BUZZER. Order Ref: 774.
COMPONENT MOUNTING TAG STRIP, 14 tags each side. Order Ref: 779.
1/2 MEG POTS each fitted double-pole switch, pack of two. Order Ref: 780.
THERMOSTAT for a refrigerator. Order Ref: 783.
C.O MICROSWITCHES operated by a wire control to spindle through side, pack of two. Order Ref: 786.
MULTI-TAG MAINS PANEL, has 12 tags to take 1/4" push-on connectors. Order Ref: 792.
REEDSWITCH, flat instead of round so many more can be stacked in a small area. Order Ref: 796.
VERY THIN DRILLS (0.3mm) pack of 12. Order Ref: 797.
ROCKER SWITCHES, spring loaded with changeover 10A 230V contacts, pack of two. Order Ref: 800.
MAINS CIRCUIT BREAKER, 7A, pushbutton operated. Order Ref: 802.
IN-LINE SWITCH intended for electric blanket to give variable heat but obviously has other uses. Order Ref: 805.
PLUG FOR CAR LIGHTER SOCKETS, each having internal fuse, pack of two. Order Ref: 809.
MAINS TRANSFORMER 12V-0V-12V, 6W. Order Ref: 811.
10M OF MAINS VOLTAGE FLEX with screen and outer PVC insulation. Order Ref: 815.
COMPUTER GRADE CAPACITOR, 10,000µF 15v. Order Ref: 816.
13A ADAPTOR to take three plugs, fused. Order Ref: 819.
13A ADAPTORS to each take 2 plugs, pack of two. Order Ref: 820.
MAINS ISOLATION TRANSFORMER 10W. Order Ref: 821.
0.01µF 250V MAINS WORKING SUPPRESSOR, pack of five. Order Ref: 836.
RING MAIN JUNCTION BOXES, 13A, 230V, pack of three. Order Ref: 801.
FLUSH PLATE LIGHT SWITCHES, 5A white, pack of two. Order Ref: 805.
OCTAL VALVE BASES, Paxolin, pack of four. Order Ref: 12.
GERMANIUM TRANSISTORS, OC45 etc, pack of 50 assorted. Order Ref: 15.
LIGHT SENSITIVE TRANSISTORS, ref. OCP70, pack of two. Order Ref: 14.
LOUDSPEAKER CROSSOVER, for tweeter, mid-range and woofer. Order Ref: 23.
KEY SWITCH, panel mounting with key. Order Ref: 31.

YOU SAVE £40



THE JAP MADE 12V 15AH SEALED LEAD ACID BATTERY from regular suppliers costs £50, you can have one from us for only £10 including VAT if you collect or £12.50 if we have to send. Being sealed it can be used in any position and is maintenance free. All in tip top condition and fully guaranteed. Order Ref: 12.5P2. Or if you want a smaller one we have 12V 2.3AH, regular price £14, yours for only £5. Order Ref: 5P258.

METAL CASES. Made from sheet aluminium with a protective grey matt coating. These are supplied as a flat pack and make up into a very useful box with a bright aluminium front making it easy to mount controls. Complete with screws and 4 rubber feet. Order Ref: 2P412 is 80mm x 46mm x 65mm, price £2 each.

Order Ref: 2.5P17 is 110mm x 50mm x 80mm, price £2.50 each.
 Order Ref: 3.5P10 is 140mm x 56mm x 110mm, price £3.50 each.

Order Ref: 4.5P7 is 180mm x 56mm x 130mm, price £4.50 each.

DOORPHONE CAMERA. Makers reference P405A, listed at the trade price of £60. We have only a limited stock of these, price £30. Order Ref: 30P12.

HEAVY DUTY PAXOLIN PANELS. Size 7 1/4" x 8", 1/8" thick, ideal for making an instrument case or just a chassis, 2 for £1. Order Ref: D105.

INSULATION TESTER WITH MULTIMETER. Internally generates voltages which enables you to read insulation directly in megohms. The multimeter has four ranges: AC/DC volts, 3 ranges milliamperes, 3 ranges resistance and 5 amp range. Ex-British Telecom, tested and guaranteed OK, yours for only £7.50 with leads, carrying case £2 extra. Order Ref: 7.5P4.

We have some of the above testers not working on all ranges, should be repairable, we supply diagram, £3. Order Ref: 3P176.

FIGURE-8 FLEX. Figure-8 flat white pvc lead, flexible with 4 sq.mm cores. Ideal for speaker extensions and bell circuits. Also adequately insulated for mains lighting. 50m coil, £2. Order Ref: 2P345. 12m coil, £1. Order Ref: 1014.

FRIEDLAND UNDERDOME BELL. Their ref: 792, a loud ninger but very neat, 3" diameter, complete with wall fixing screws, £5. Order Ref: 5P232.

HIGH CURRENT A.C. MAINS RELAY. This has a 230V coil and changeover switch rated at 15A with PCB mounting with clear plastic cover, £1. Order Ref: 965.

YOU CAN STAND ON IT! Made to house GPO telephone equipment, this box is extremely tough and would be ideal for keeping your small tools in. Internal size approx. 10 1/2" x 4 1/2" x 6" high. Complete with carrying strap, price £2. Order Ref: 2P283B.

ULTRASONIC TRANSDUCERS. Two metal cased units, one transmits, one receives. Built to operate around 40kHz. Price £1.50 the pair. Order Ref: 1.5P/4.

BIG BUYER

Please note if you order 10 of an item you may deduct 10%. If you order 25, then deduct 25% but add VAT. If you need 100 or more, you can usually deduct 40% but please ring to confirm.

MAINS 230V FAN. Best make "PAPST", 4 1/2" square, metal blades, £8. Order Ref: 8P8.

12V 10A SWITCH MODE POWER SUPPLY. For only £9.50 and a little bit of work because you have to convert our 135W PSU. Modifications are relatively simple — we supply instructions. Simply order PSU Ref: 9.5P2 and request modification details, price still £9.50.

VERY POWERFUL MAINS MOTOR. With extra long (2 1/2") shafts extending out each side. Makes it ideal for a reversing arrangement for, as you know, shaded-pole motors are not reversible, £3. Order Ref: 3P157.

45A DOUBLE-POLE MAINS SWITCH. Mounted on a 6" x 3 1/2" aluminium plate, beautifully finished in gold, with pilot light. Top quality, made by MEM, £2. Order Ref: 2P316.

LAMP DIMMER. Suitable for up to 250W, on standard plate so fits directly in place of existing switch. Coloured red, blue, yellow or green but will take emulsion paint, £2 each. Order Ref: 2P380.

PHILIPS 9" HIGH RESOLUTION MONITOR. Black and white in metal frame for easy mounting. Brand new, still in maker's packing, offered at less than price of tube alone, only £15. Order Ref: 15P1.

12V/24V DC SOLENOID. The construction of this is such that it will push or pull. With 24V this is terrifically powerful but is still quite good at 12V, £1. Order Ref: 877.

DON'T STAND OUT IN THE COLD. Our 12m telephone extension lead has a flat BT socket one end and flat BT plug other end, £2. Order Ref: 2P338.

20 W 5" 4 OHM SPEAKER, £3. Order Ref: 3P145. Matching 4 ohm 20W tweeter, £1.50. Order Ref: 1.5P9.

£3 BARGAIN PACKS

MAINS SUPPRESSOR/FILTER, 25A. Order Ref: 3P13.
SIGNAL BOX, 3 pilot lamps in white metal case. Order Ref: 3P16.
120W CHOKE, 8ft tube. Order Ref: 3P17.
KEYBOARD intended for OPD computer. Order Ref: 3P27.
SOLAR CELL, 750mA. Order Ref: 3P42.
PROJECT BOX with lid, 165mm x 119mm x 75mm. Order Ref: 3P49.
INSTRUMENT TYPE MAINS INPUT SOCKET with built-in filter. Order Ref: 3P50.
6-CORE 5A FLEX, 12m. Order Ref: 3P54.
20V 3A MAINS TRANSFORMER. Order Ref: 3P59.
20V 4A MAINS TRANSFORMER. Order Ref: 3P106.
36V 3A MAINS TRANSFORMER. Order Ref: 3P14.
40V 2A MAINS TRANSFORMER. Order Ref: 3P107.
20V-0V-20V 40VA MAINS TRANSFORMER. Order Ref: 3P205.
1/8RPM 2W MOTOR. Order Ref: 3P64.
METAL PROJECT BOX, size 8" x 4 1/2" x 4", made for GPO. Order Ref: 3P74.
THIN CONNECTING WIRE, 2-cores twisted together, full length 500m. Order Ref: 3P78.
12V 1A PSU, filtered and regulated on PCB with relays and Piezo sounder. Order Ref: 3P80.
HORN SPEAKER, 8 Ohm, size 4 1/4". Order Ref: 3P82.
20A TIME SWITCH, ex-electricity board. Order Ref: 3P84.
ABS PROJECT BOX, 145mm x 95mm x 58mm. Order Ref: 3P85.
HEAT AND LIGHT LAMP BC 250W. Order Ref: 3P86.
16-IN-ONE TOOL KIT. Order Ref: 3P100.
RAINBOW PIANO with tune chart. Order Ref: 3P101.
BT INSULATION TESTER, faulty but should be repairable. Supplied with circuit diagram. Order Ref: 3P103.
MODERN TELEPHONE HANDSET without dial, cream. Order Ref: 3P104.
3-CORE 20A FLEX, 10m. Order Ref: 3P109.
2-CORE 20A FLEX, 15m. Order Ref: 3P110.
QUARTZ CLOCK MOVEMENT with hours, minutes and seconds hands and mounting bracket. Order Ref: 3P111.
20W LOUDSPEAKER, 5" 4 Ohm by Goodmans. Order Ref: 3P145.
CUPBOARD DOOR ALARM. Order Ref: 3P155.
WATER LEVEL ALARM, fully adjustable. Order Ref: 3P156.
HEAVY DUTY MAINS MOTOR with 2 1/2" spindle each side. Order Ref: 3P157.
RESETTABLE 6-DIGIT 12V COUNTER. Order Ref: 3P158.
0V-10V PANEL METER. Order Ref: 3P159.
6FT MINERAL FILLED METAL CLAD 1,000W ELEMENT. Order Ref: 3P161.
TIME AND SET SWITCH for mains at 30A. Order Ref: 3P164.
25A 3-CORE FLEX, 10m. Order Ref: 3P166.
AMSTRAD 8" 15W WOOFER. Order Ref: 3P167.
12V BRUSHLESS FAN mounted in frame with its own drive circuit. Order Ref: 3P168.
SOLENOID AIR VALVE 110V. Order Ref: 3P178.
TRANSFORMER AND RECTIFIER for 12V charger. Order Ref: 3P180.
WALL MOUNTING MAINS THERMOSTAT. Order Ref: 3P182.
5" 8 OHM SPEAKER in WOODEN CABINET. Order Ref: 3P183.
MULTICORE VIDEO LEAD with end plugs. Order Ref: 3P187.
D.C. PANEL METER, 0V to 20V. Order Ref: 3P188.
12µF 660V A.C. CAPACITOR. Order Ref: 3P203.
14µF 400V A.C. CAPACITOR. Order Ref: 3P199.
15µF 440V A.C. CAPACITOR. Order Ref: 3P190.
20µF 440V A.C. CAPACITOR. Order Ref: 3P191.
25µF 370V A.C. CAPACITOR. Order Ref: 3P192.
500µF 350V ELECTROLYTIC CAPACITOR. Order Ref: 3P204.
MINI STEPPER MOTOR, 1.5 degree steps. Order Ref: 3P193.
MAINS OPERATED WATER VALVE, suit high or low pressure. Order Ref: 3P192.
AMSTRAD AMPLIFIER, ref no. not known, is stereo and has 10 LED's on front panel. Order Ref: 3P195.
HALOGEN LAMP 12V 20W. Order Ref: 3P200.

£4 BARGAIN PACKS

MOTORISTS LEAD LAMP, hand grip plastic body, glass lamp cover and heavy duty wire shield with hanging bracket. Order Ref: 4P31.
120W TRANSFORMER 40V at 3A output. Order Ref: 4P15.
100W TRANSFORMER, main winding 28V at 3 1/2A, secondary winding 20V-0V-20V at 1A. Order Ref: 4P24.
7.5V-0V-7.5V 6A MAINS TRANSFORMERS, upright mounting with fixing feet. Order Ref: 4P98.
PANEL METER 0-100µA, 100mm x 100mm, complete with glass front but less scale. Order Ref: 4P32.
DITTO but 100-0-100µA. Order Ref: 4P32A.
80W TRANSFORMER 20V-0V-20V with one winding tape at 18V. Order Ref: 4P36.
AMSTRAD 8" 15W SPEAKER with matching tweeter, 8 Ohm. Order Ref: 4P57.
FAN 12V or lower for reduced speed, made by Jap Nipon, body size 93mm x 93mm. Order Ref: 4P65.
STRIPPER BOARD with lots of IC's, all plug-in, ex-Sentinal phone control unit. Order Ref: 4P67.
AM/FM RADIO, nicely cased with clip for attaching to cycle. Order Ref: 4P72.
VENNER TIME SWITCH, 24hr, day length controller, ex-electricity board. Order Ref: 4P74.
EMI 2-SPEED MOTOR 100 r.p.m. and 500 r.p.m., reversible. Order Ref: 4P80.
LARGE PANEL METER, scaled 20-0-40A but needs a shunt. Order Ref: 4P91.
2-PART METAL CASE, ideal car battery charger, etc. Order Ref: 4P89.
JAPANESE PRECISION MADE MOTOR, reversible, 1500rpm. Order Ref: 4P94.

Prices include VAT and carriage cost if order over £25 otherwise add £3. Send cash, uncrossed postal orders, cheque or quote credit card number.

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SURVEILLANCE PROFESSIONAL QUALITY KITS

No. 1 for Kits

Whether your requirement for surveillance equipment is amateur, professional or you are just fascinated by this unique area of electronics SUMA DESIGNS has a kit to fit the bill. We have been designing electronic surveillance equipment for over 12 years and you can be sure that all our kits are very well tried, tested and proven and come complete with full instructions, circuit diagrams, assembly details and all high quality components including fibreglass PCB. Unless otherwise stated all transmitters are tuneable and can be received on an ordinary VHF FM radio.

Genuine SUMA kits available only direct from Suma Designs. Beware inferior imitations!

UTX Ultra-miniature Room Transmitter

Smallest room transmitter kit in the world! Incredible 10mm x 20mm including mic. 3V-12V operation. 500m range..... **£16.45**

MTX Micro-miniature Room Transmitter

Best-selling micro-miniature Room Transmitter. Just 17mm x 17mm including mic. 3V-12V operation. 1000m range..... **£13.45**

STX High-performance Room Transmitter

High performance transmitter with a buffered output stage for greater stability and range. Measures 22mm x 22mm, including mic. 6V-12V operation, 1500m range. **£15.45**

VT500 High-power Room Transmitter

Powerful 250mW output providing excellent range and performance. Size 20mm x 40mm. 9V-12V operation. 3000m range..... **£16.45**

VXT Voice-Activated Transmitter

Triggers only when sounds are detected. Very low standby current. Variable sensitivity and delay with LED indicator. Size 20mm x 67mm. 9V operation. 1000m range. **£19.45**

HVX400 Mains Powered Room Transmitter

Connects directly to 240V A.C. supply for long-term monitoring. Size 30mm x 35mm. 500m range..... **£19.45**

SCRX Subcarrier Scrambled Room Transmitter

Scrambled output from this transmitter cannot be monitored without the SCDM decoder connected to the receiver. Size 20mm x 67mm. 9V operation. 1000m range..... **£22.95**

SCSX Subcarrier Telephone Transmitter

Connects to telephone line anywhere, requires no batteries. Output scrambled so requires SCDM connected to receiver. Size 32mm x 37mm. 1000m range..... **£23.95**

SCDM Subcarrier Decoder Unit for SCRX

Connects to receiver earphone socket and provides decoded audio output to headphones. Size 32mm x 70mm. 9V-12V operation..... **£22.95**

ATR2 Micro-Size Telephone Recording Interface

Connects between telephone line (anywhere) and cassette recorder. Switches tape automatically as phone is used. All conversations recorded. Size 16mm x 32mm. Powered from line..... **£13.45**

UTLX Ultra-miniature Telephone Transmitter

Smallest telephone transmitter kit available. Incredible size of 10mm x 20mm! Connects to line (anywhere) and switches on and off with phone use. All conversation transmitted. Powered from line. 500m range..... **£15.95**

TLX 700 Micro-miniature Telephone Transmitter

Best-selling telephone transmitter. Being 20mm x 20mm it is easier to assemble than UTLX. Connects to line (anywhere) and switches on and off with phone use. All conversations transmitted. Powered from line. 1000m range..... **£13.45**

STLX High-performance Telephone Transmitter

High performance transmitter with buffered output stage providing excellent stability and performance. Connects to line (anywhere) and switches on and off with phone use. All conversations transmitted. Powered from line. Size 22mm x 22mm. 1500m range..... **£16.45**

TKX900 Signalling/Tracking Transmitter

Transmits a continuous stream of audio pulse, with variable tone and rate. Ideal for signalling or tracking purposes. High power output giving range up to 3000m. Size 25mm x 63mm. 9V operation..... **£22.95**

CD400 Pocket Bug Detector/Locator

LED and piezo bleeper pulse slowly, rate of pulse and pitch of tone increase as you approach signal. Gain control allows pinpointing of source. Size 45mm x 54mm. 9V operation..... **£30.95**

CD600 Professional Bug Detector/Locator

Multicolour readout of signal strength with variable rate bleeper and variable sensitivity used to detect and locate hidden transmitters. Switch to AUDIO CONFORM mode to distinguish between localised bug transmission and normal legitimate signals such as pagers, cellular, taxis etc. Size 70mm x 100mm. 9V operation..... **£50.95**

QTX180 Crystal Controlled Room Transmitter

Narrow band FM transmitter for the ultimate in privacy. Operates on 180MHz and requires the use of a scanner receiver or our QRX180 kit (see catalogue). Size 20mm x 67mm. 9V operation. 1000m range..... **£40.95**

QLX180 Crystal Controlled Telephone Transmitter

As per QTX180 but connects to telephone line to monitor both sides of conversations. 20mm x 67mm. 9V operation. 1000m range..... **£40.95**

QSX180 Line Powered Crystal Controlled Phone Transmitter

As per QLX180 but draws power requirements from line. No batteries required. Size 32mm x 37mm. Range 500m..... **£35.95**

QRX 180 Crystal Controlled FM Receiver

For monitoring any of the Q range transmitters. High sensitivity unit. All RF section supplied as pre-built and aligned module ready to connect on board so no difficulty setting up. Output to headphones. 60mm x 75mm. 9V operation..... **£60.95**

A build-up service is available on all our kits if required.

UK customers please send cheques, POs or registered cash. Please add £1.50 per order for P&P. Goods despatched ASAP allowing for cheque clearance. Overseas customers send Sterling Bank Draft and add £5.00 per order for shipment. Credit card orders welcomed on 01827 714476.

OUR LATEST CATALOGUE CONTAINING MANY MORE NEW SURVEILLANCE KITS NOW AVAILABLE. SEND TWO FIRST CLASS STAMPS OR OVERSEAS SEND TWO IRCS.

★★★ Specials ★★★

DLTX/DLRX Radio Control Switch

Remote control anything around your home or garden, outside lights, alarms, paging system etc. System consists of a small VHF transmitter with digital encoder and receiver unit with decoder and relay output, momentary or alternate, 8-way d.i.l. switches on both boards set your own unique security code. TX size 45mm x 45mm. RX size 35mm x 90mm. Both 9V operation. Range up to 200m.

Complete System (2 kits)..... **£50.95**

Individual Transmitter DLTX..... **£19.95**

Individual Receiver DLRX..... **£37.95**

MRX-1 Hi-Fi Micro Broadcaster

Not technically a surveillance device but a great idea! Connects to the headphone output of your Hi-Fi, tape or CD and transmits Hi-Fi quality to a nearby radio. Listen to your favourite music anywhere around the house, garden, in the bath or in the garage and you don't have to put up with the DJ's choice and boring waffle.

Size 27mm x 60mm. 9V operation. 250m range..... **£20.95**

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EPE MICROCONTROLLER P.I. TREASURE HUNTER

The latest MAGENTA DESIGN - highly stable & sensitive - with MC control of all timing functions and advanced pulse separation techniques.

● New circuit design 1994

● High stability
drift cancelling

● Easy to build
& use

● No ground
effect, works
in seawater



● Detects gold,
silver, ferrous &
non-ferrous
metals

● Efficient quartz controlled
microcontroller pulse generation.

● Full kit with headphones & all
hardware

KIT 847.....£63.95

DIGITAL LCD THERMOSTAT

A versatile thermostat using a thermistor probe and having an I.C.D. display, MIN/MAX memories, -10 to 110 degrees celsius, or can be set to read in Fahrenheit. Individually settable upper and lower switching temperatures allow close control, or alternatively allow a wide 'dead band' to be set which can result in substantial energy savings when used with domestic hot water systems. Ideal for greenhouse ventilation or heating control, aquaria, home brewing, etc. Mains powered, 10A SPCO relay output. Punched and printed case.

KIT 841.....£29.95

PORTABLE ULTRASONIC PeST SCARER

A powerful 23kHz ultrasound generator in a compact hand-held case. MOSFET output drives a special sealed transducer with intense pulses via a special tuned transformer. Sweeping frequency output is designed to give maximum output without any special setting up.

KIT 842.....£22.56

DIGITAL CAPACITANCE METER

A really professional looking project. Kit is supplied with a punched and printed front panel, case, p.c.b. and all components. Quartz controlled accuracy of 1%. Large clear 5 digit display and high speed operation. Ideal for beginners - as the μF , nF and pF ranges give clear unambiguous read out of marked and unmarked capacitors from a few pF up to thousands of μF .

KIT 493.....£39.95

ACOUSTIC PROBE

A very popular project which picks up vibrations by means of a contact probe and passes them on to a pair of headphones or an amplifier. Sounds from engines, watches, and speech travelling through walls can be amplified and heard clearly. Useful for mechanics, instrument engineers, and nosy parkers!

KIT 740.....£19.98

WINDICATOR

A novel wind speed indicator with LED read-out. Kit comes complete with sensor cups, and weatherproof sensing head. Mainspower unit £5.99 extra.

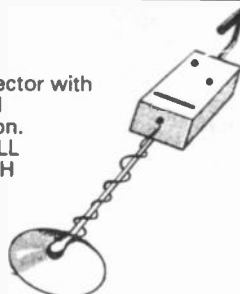
KIT 856.....£28.00

BUCCANEER I.B. METAL DETECTOR

An Induction Balance (I.B.) detector with audible output. Providing good sensitivity and easy construction. COMPLETE KIT - INCLUDES ALL HARDWARE, HANDLE, SEARCH HEAD, PCB etc.

CIRCUIT REJECTS IRON
WHILST PICKING UP GOLD,
SILVER, COPPER etc.
A SOLID RELIABLE DESIGN.

KIT 719.....£54.99



1000V & 500V INSULATION TESTER

Superb new design. Regulated output, efficient circuit. Dual-scale meter, compact case. Reads up to 200 Megohms.

Kit includes wound coil, cut-out case, meter scale, PCB & ALL components.

KIT 848.....£32.95

MOSFET MkII VARIABLE BENCH POWER SUPPLY 0-25V 2.5A.

Based on our MkI design and preserving all the features, but now with switching pre-regulator for much higher efficiency. Panel meters indicate Volts and Amps. Fully variable down to zero. Toroidal mains transformer. Kit includes punched and printed case and all parts. As featured in April 1994 EPE. An essential piece of equipment.

KIT 845.....£64.95



ULTRASONIC PeST SCARER

Keep pets/pests away from newly sown areas, fruit, vegetable and flower beds, children's play areas, patios etc. This project produces intense pulses of ultrasound which deter visiting animals.

● KIT INCLUDES ALL
COMPONENTS, PCB & CASE

● EFFICIENT 100V
TRANSDUCER OUTPUT

● COMPLETELY INAUDIBLE
TO HUMANS

● UP TO 4 METRES
RANGE

● LOW CURRENT DRAIN

KIT 812.....£14.81



SPACEWRITER

An innovative and exciting project. Wave the wand through the air and your message appears. Programmable to hold any message up to 16 digits long. Comes pre-loaded with "MERRY XMAS". Kit includes PCB, all components & tube + instructions for message loading.

KIT 849.....£16.99

12V EPROM ERASER

A safe low cost eraser for up to 4 EPROMs at a time in less than 20 minutes. Operates from a 12V supply (400mA). Used extensively for mobile work - updating equipment in the field etc. Also in educational situations where mains supplies are not allowed. Safety interlock prevents contact with UV.

KIT 790.....£28.51

MOSFET 25V 2.5A POWER SUPPLY

High performance design has made this one of our classic kits. Two panel meters indicate Volts and Amps. Variable from 0-25 Volts and current limit control from 0-2.5A. Rugged power MOSFET output stage. Toroidal mains transformer.

KIT 769.....£56.82

INSULATION TESTER

A reliable and neat electronic tester which checks insulation resistance of wiring and appliances etc., at 500 Volts. The unit is battery powered, simple and safe to operate. Leakage resistance of up to 100 Megohms can be read easily. A very popular college project.

KIT 444.....£22.37

DIGITAL COMBINATION LOCK

Digital lock with 12 key keypad. Entering a four digit code operates a 250V 16A relay. A special anti-tamper circuit permits the relay board to be mounted remotely. Ideal car immobiliser, operates from 12V. Drilled case, brushed aluminium keypad.

KIT 840.....£19.86

E.E. TREASURE HUNTER P.I. METAL DETECTOR MKI

Magenta's highly developed & acclaimed design. Quartz crystal controlled circuit MOSFET coil drive. D.C. coupled amplification. Full kit includes PCB, handle, case & search coil.

● KIT INC.
HEADPHONES

● EFFICIENT
CMOS DESIGN

● POWERFUL COIL
DRIVE

● DETECTS FERROUS AND
NON-FERROUS METAL - GOLD,
SILVER, COPPER ETC.

● 190mm SEARCH COIL

● NO 'GROUND EFFECT'

KIT 815.....£45.95



DOLBY PRO-LOGIC DECODER

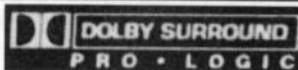
Experience the delight of SURROUND SOUND in your own home. This project brings full Genuine PRO-LOGIC surround sound to you at a fantastic price. The circuit meets all 'Dolby' specifications, with "Stereo", "3-Stereo" and "Surround Sound" selections. Exactly as described in this booklet.

For minimum cost the "Short Form Kit" is ideal. This is complete except for the case and power transformer. It includes the switches, sockets, and pots, and is ideal for building into a custom set-up with pre-amp and power-amp modules, where power is available.

The alternative "Full Kit" gives the best value option. With a printed front panel, punched rear panel, power transformer and mains lead and black brushed aluminium knobs. This kit produces a complete stand-alone decoder that can be used with any audio.

Short Form KIT, Kit Ref: 858 £99.00

Kit with case and transformer, Kit Ref: 869 £124.99



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DC Motor/Gearboxes

Our Popular and Versatile DC motor/Gearbox sets. Ideal for Models, Robots, Buggies etc. 1.5 to 4.5V Multi ratio gearbox gives wide range of speeds.

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Stepping Motors

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MD24...Large 200 step...£22.95

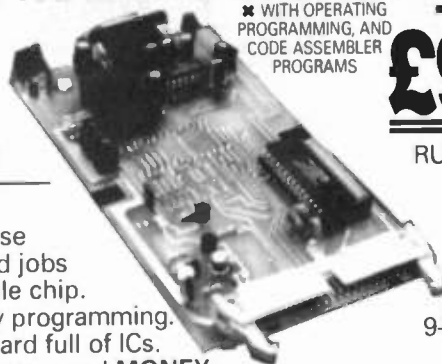
PIC

DEVELOPMENT & TRAINING SYSTEM

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STEP 3 - Start writing and testing your own programs

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A real-world application for a PIC microchip. This project can be made to do just what you chose by writing your own software. It can be programmed to work as a 4-Channel Light Chaser or a simple controller for domestic lighting. Zero volt crossing signal is provided and there is a 4x3 matrix keypad. (Less case).

Kit 855.....**£35.95**

PIC 16C84 DISPLAY DRIVER

NEW!

USES PIC16C84 to drive a 2 LINE x 16 LCD Display.

Another **NEW** PIC project from Magenta. Supplied with PCB, industry standard 2 line x 16 character display, PIC16C84, components, and software to include in your own programs. Full display data and program service code is supplied. Ideal development base for meters, terminals, calculators, counters, timers etc. Just waiting for your application.

KIT Ref. 860.....**£17.99**

SIMPLE PIC16C84 PROGRAMMER

Based on the design in February '96 EPE. Magenta have made a proper PCB for this circuit and a full kit of parts. The PCB eliminates the risk of layout errors. Additional contact points are provided to allow connection to RA and unused RB pins when testing programs. Kit includes 1 - PIC16C84 chip, lead, connector and all software.

Programmer Kit - with software disk, lead, connector and PIC16C84 chip, including PCB.
 Kit 857.....**£12.99**

Power Supply Unit 12V-14V.....**£3.99**

Extra PIC16C84 Chips.....**£7.36**

KIT HIGHLIGHT

We have noticed a number of customers buying the PIC 16C84 Programmer and Kit 855. This is an ideal combination. Kit 855 allows Mains Power to be controlled safely using a PIC16C84. Experiment with chaser patterns and dimming using phase control. Special kit with all components and blank PIC16C84 and reprints.
 Kit 855/16C84.....**£39.95**

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Never before at this price! Our own 68000 board kit. Used all over the world in schools and universities. Double Eurocard PCB with RAM, ROM, and I/O. Full featured MONITOR and LINE BY LINE ASSEMBLER ON BOARD. Just needs power, and a serial link to your PC. Supplied with full data and applications course. Use to learn, or as a star J-alone computer board.

£55.00!
 Kit Ref 601



BAT DETECTOR



An excellent circuit which reduces ultrasound frequencies between 20 and 100 kHz to the normal (human) audible range. Operating rather like a radio receiver the circuit allows the listener to tune-in to the ultrasonic frequencies of interest. Listening to Bats is fascinating, and it is possible to identify various different types using this project. Other uses have been found in industry for vibration monitoring etc.

KIT 814.....**£21.44**

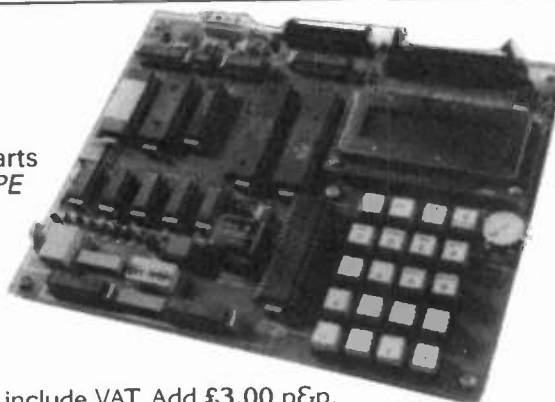
Mini-Lab & Micro Lab Electronics Teach-In 7

As featured in EPE and now published as Teach-In 7. All parts are supplied by Magenta. Teach-In 7 is £3.95 from us or EPE
 Full Mini Lab Kit - £119.95 - Power supply extra - £22.55
 Full Micro Lab Kit - £155.95 Built Micro Lab - £189.95

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4010	74HC10	74LS10	74ALS10
4011	74HC11	74LS11	74ALS11
4012	74HC12	74LS12	74ALS12
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4097	74HC97	74LS97	74ALS97
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LF353N	£0.42	2712K-20	£4.08	BR39	£1.30
LF356	£0.84	27C12K-20	£4.08	Transistors	
LM301A	£0.25	27256-20	£4.85	2N1613	£0.31
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LM393N	£0.21	AD574AJN	£18.48	2N3439	£0.62
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LM759CP	£3.38	AD7528JN	£8.63	2N3704	£0.10
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MC1488	£0.39	78L15	£0.23	µF	
MC1489	£0.59	78L24	£0.28	0.47	
MC3302	£0.56	79L05	£0.28	1.0	
MC3340P	£1.60	79L08	£0.28	2.2	
MC4558K	£0.36	79L12	£0.23	4.7	
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SSM2141P	£4.21	BA157	£0.10		
SSM2142P	£4.21	BA158	£0.10		
SSM2143P	£3.78	BA159	£0.10		
TBA1205	£0.90	BY126	£0.13		

EVERYDAY PRACTICAL ELECTRONICS

VOL. 25 No. 7

JULY '96

THE CHANGE IN COMMUNICATIONS

For the last ten years we have published the regular *Amateur Radio* page by Tony Smith G4FAI; if you read it this month you will find Tony signing off. There is always considerable pressure on our page space and it is with some regret that we have asked Tony to move aside for our new *Net Work* page on the Internet and all that stuff.

Amateur Radio is as valid a hobby as it has ever been, even though most practitioners now use ready made equipment rather than the d.i.y. designs that dominated twenty years ago. The hobby has many facets and a large proportion of users also employ computers as an integral part of their radio operation. However, as the Internet continues to develop we find our readers more interested in this digital form of electronic communication.

You could say that our regular communications page is simply changing from radio to a digital network system. We won't just show you pictures of what you can see on screen but we will be telling you about all the interesting sites you can visit, about who is new on The Net and where you can find information, answers and ideas that will help with your hobby, training or employment in electronics.

Communication via computer and phone line has rapidly expanded around the World and it is estimated that over 35 million people are now connected – they are all out there waiting to interact with you. As an example of just how useful this communications media can be we recently found two suppliers of an "unobtainable" i.e. within a few hours of putting out a request on The Net – one an American company who made a direct response and one a UK company whose name was provided by another Net user. In previous circumstances of this type we have spent much time, energy and money phoning and faxing manufacturers and distributors around the World, more often than not with negative results. This time one E-mail request, at the cost of a one minute local phone call, brought almost instant results.

ASSURANCE

Over the months I have continued to assure readers who want nothing to do with computers that *EPE* will cater for their needs and I now reiterate that assurance – only about three regular pages of the magazine are dedicated to computers. However, they are becoming incredibly useful in electronics, particularly when programming PIC projects, for use as virtual test instruments and as circuit design tools, etc., as well as for communication. We, therefore, anticipate that the majority of readers will eventually employ this tool as part of their hobby.

Mike Kenward

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ADVANCED NiCad CHARGERS

ANDY FLIND

Keep your NiCad rechargeables performing at their peak with one of these low-cost "power brokers."

- You won't be overcharged!

Can be tailored to charge AA, C or D-size cells.

CHARGERS for rechargeable NiCad batteries are fairly common nowadays. Various types are available which accept a variety of cell sizes and capacities, and some are quite sophisticated. The problem is that some are not, especially at the cheaper end of the market.

Readers may wonder exactly what current is being pushed into their expensive cells, especially when they start to become warm! Another difficulty occurs when the user forgets to remove the cells on completion of charging, so that they carry on receiving current long after the full charge has been achieved.

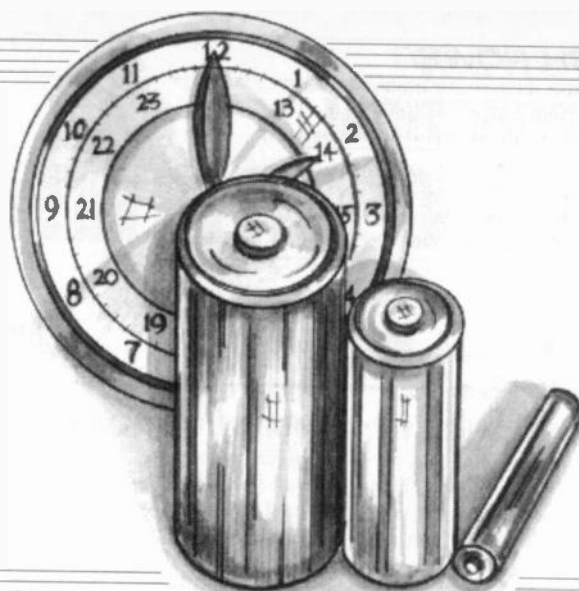
Two circuits are presented here. The first will provide a precise charging current that can be tailored to suit the cells to be charged, whilst the second has an additional feature for reducing the charge rate after a suitable period to keep the cells fresh and ready for use without damaging them.

This circuit was originally developed for charging the eight-cell pack in the recent *Mind Machine* (March to May '96) project, but the design is very flexible and can be adapted to suit a wide variety of other charging applications, as will be explained. It may even be built to deliver the 400mA required by industrial "D" size cells.

CONSTANT CURRENT

The first version develops a current which remains constant, regardless of load, so long as sufficient supply voltage is available. The circuit diagram for the Constant Current version appears in Fig. 1.

A tapped transformer T1 with two rectifier diodes D1 and D2 and capacitor C1 provides the primary d.c. supply from the 230V a.c. mains. The power MOSFET device TR3 is initially biased into conduction by a positive gate voltage from resistor R3.



The apparent brightness of l.e.d. D3 therefore depends on the charging current, so any problems with connection to the cells on charge will be immediately apparent to the user. Diode D5 prevents any "back-feeding" of current from the batteries should there be a failure of the mains supply whilst they are still connected.

ON THE BOARD

The Constant Current circuit could be constructed on the main Timed Charger p.c.b., with a link to bypass the timer section. Alternatively, it can be assembled quickly and cheaply on a piece of 0.1in. matrix stripboard to the layout shown in Fig. 2, which also shows the underside of the board with track breaks and soldered connections.

For charging AA cells, the component values shown are correct and the small home-made heatsink, bent from a piece of aluminium sheet, will be sufficient. A mains transformer with a 15V-0V-15V secondary winding will supply adequate voltage for eight cells, and a 100mA type will suffice for the 60mA or so of output needed. If four or less cells are to be charged, a 9V-0V-9V mains transformer can be used instead.

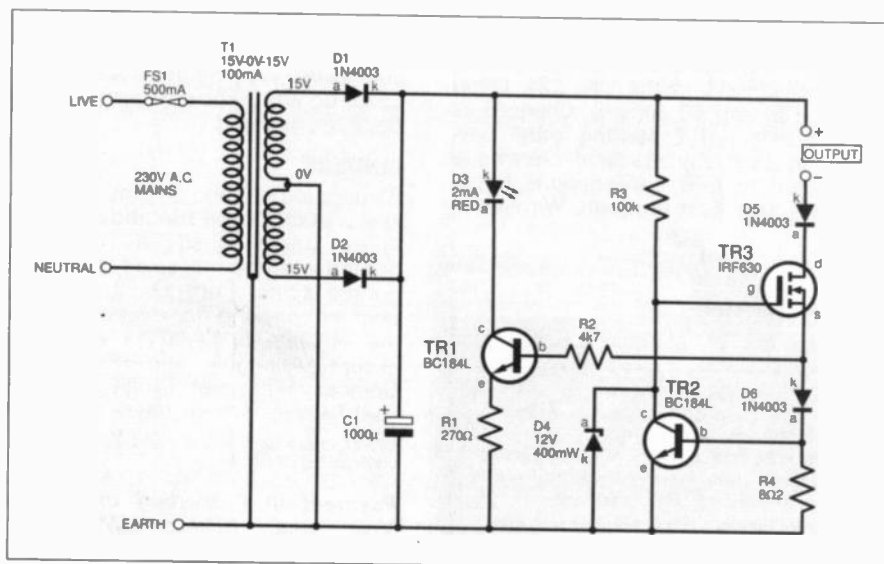


Fig. 1. Circuit diagram for the Constant Current NiCad Charger (values shown are for up to eight AA cells).

HIGH POWER

To use the unit for higher currents, some component values will need alteration and a larger heatsink may also be necessary. The most common types of NiCad are "AA", "C" and "D" size cells.

Usually, AA types require about 50mA to 60mA charging current, though variations with higher capacities and charging currents are starting to appear. C-size cells usually need around 200mA. Most D-cells also require 200mA for charging, as they are actually C-size units in larger cases.

However, there is an industrial type D-cell with a 4-amp/hour capacity that uses a 400mA charging current. These are easily distinguishable by price and weight, apart from the markings on their cases.

The mains transformer can be selected simply for an adequate secondary current rating. A larger value of capacitor C1 may be needed to keep supply ripple to an acceptable level. Whilst the 1000µF shown is fine for 60mA, a 2200µF component should be used for 200mA and a 4700µF for 400mA, all of which will keep ripple to less than one volt peak-to-peak.

The current setting resistor R4 should be chosen using the formula $R = 0.5/I$, where I is the required charging current in amperes. A 2.2 ohm resistor will deliver about 230mA and a 1.2 ohm one about 400mA, although with a 400mA output the heat dissipation in this resistor will be about 0.2W so it might be appropriate to use two 2.2 ohm resistors in parallel to spread the dissipation.

HEATSINK

The heatsink for the power MOSFET TR3 also requires consideration. It can handle several amps of current, but will

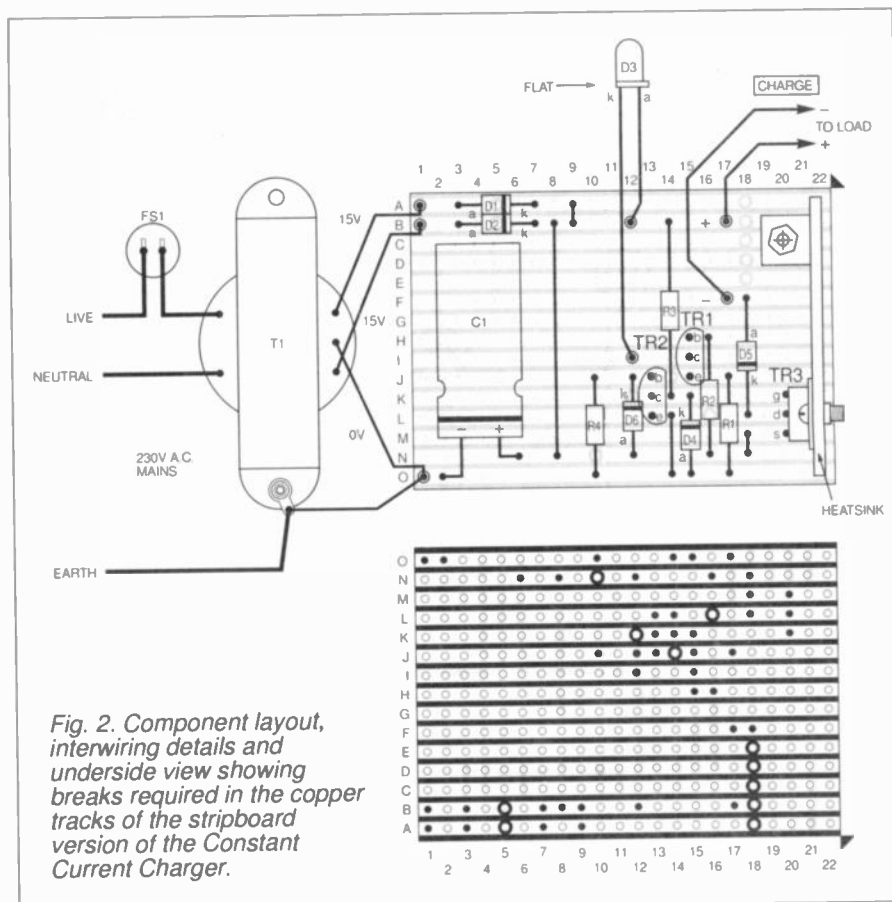


Fig. 2. Component layout, interwiring details and underside view showing breaks required in the copper tracks of the stripboard version of the Constant Current Charger.

dissipate a wattage equal to the voltage across it multiplied by the output current. This voltage is calculated as the primary supply less the voltage lost elsewhere.

Diodes D5 and D6 drop about 1.2V between them, whilst another 0.5V is lost across resistor R4. The voltage across the batteries varies, but is roughly 1.2V per cell, assuming they are all healthy.

With a 15V supply, loaded so that it is actually closer to 15V than the "peak" value of just over 20V, and a pack of eight cells all at correct voltage, the drop across TR3 is only 3.7V which at 60mA represents 220mW. With a pack of four cells the dissipation will be half a watt, so if this is the number that will normally be charged it may be worth using a 9V or 12V transformer.

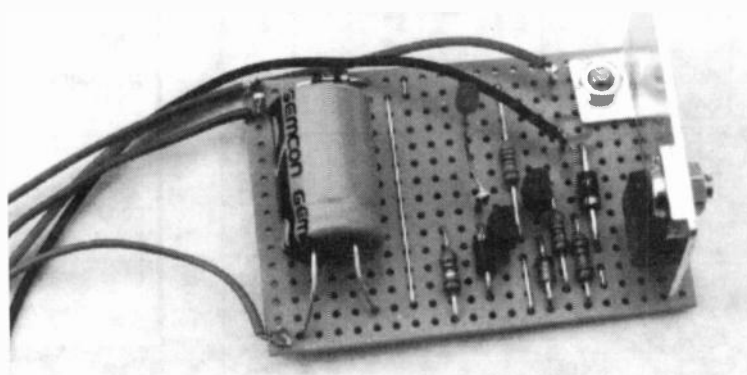
Four D-cells, on the other hand, with a charging current of 400mA and a 15V transformer, will cause a dissipation of around three and a half watts by TR3,

requiring a fairly large heatsink and free air circulation. However, the option of selecting components in this way makes it possible to construct an ideal charger for almost any NiCad battery.

CONSTRUCTION

Construction of the Constant Current Charger to the layout of Fig. 2 should be straightforward, though the usual checks for solder bridges and particles of copper strip remaining around the edges of "breaks", so easy to miss on stripboard, should be made. Start with the four wire links followed by the smaller components working up to the electrolytic capacitor, except the transistors which should be inserted last. Check for correct polarities before soldering in diodes, transistors and the electrolytic capacitor.

The interwiring between the various off-board components and the circuit board are also shown in Fig. 2.



Constant Current Charger built on stripboard.

COMPONENTS

CONSTANT CURRENT NiCad CHARGER

Resistors

R1	270Ω
R2	4k7
R3	100k
R4*	8Ω

All 0.6W 1% metal film

Capacitors

C1*	1000µ radial elect. 35V
-----	-------------------------

Semiconductors

D1, D2,	
D5, D6	1N4003 1A 200V rec. diode (4 off)
D3	2mA red l.e.d.
D4	12V 400mW Zener diode
TR1, TR2	BC184L npn silicon transistor (2 off)
TR3	IRF630 n-channel power MOSFET

Miscellaneous

T1*	Miniature 100mA mains transformer, with 15V-0V-15V secondary
FS1	500mA 20mm fuse, with panel mounting holder
Stripboard, 0.1in. matrix, size 15 strips x 22 holes; piece of aluminium for heatsink - see text; l.e.d. clips; battery clips; connecting wire; solder etc.	

*Alter for different output currents - see text.

Approx Cost
Guidance Only

£8

The second timer is used as an inverter to convert this to a high output which, via resistor R8, activates the output constant current generator. When IC1 times out, the oscillator in IC2 starts running, and the current generator is then pulsed for about 400ms every two seconds.

NiCads have quite a high self-discharge rate of about 10 per cent capacity per week. If left on this charger they will be kept fully topped up ready for use without overcharging, and by flashing in time with the current pulses the l.e.d. D10 will let the user know that the main charge period is complete. The output stage is identical to the simple non-timed circuit, save that the MOSFET bias is taken from the timer instead of the main positive supply.

CONSTRUCTION

To simplify construction, the Timed NiCad Charger version is built on a printed circuit board (p.c.b.). This board also takes the mains transformer and the component layout. Full size copper foil master details are given in Fig. 4. This board is available from the *EPE PCB Service*, code 100.

Construction on the p.c.b. is straightforward, though a few notes on construction and testing should help.

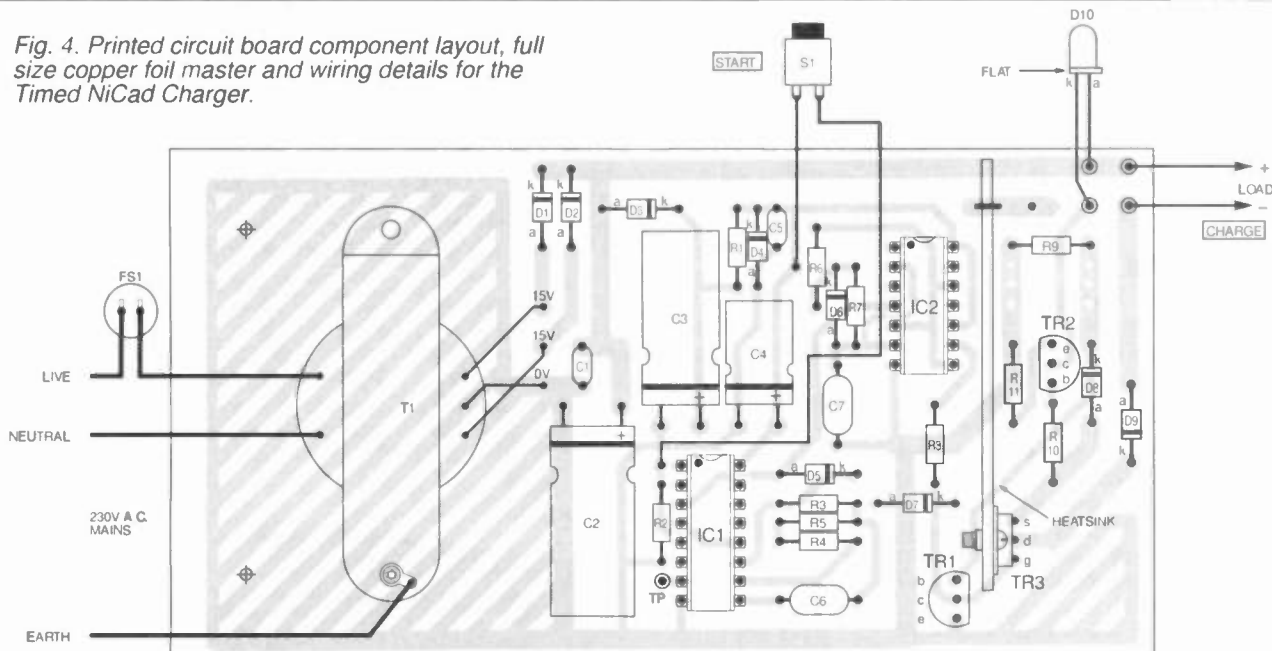


Miniature 100mA and 250mA mains transformers can be bolted directly to the board. A solder tag should be placed under one of the mounting screws and used as the "Earth" connection, this will effectively earth both the transformer metalwork and the circuit's negative (0V)

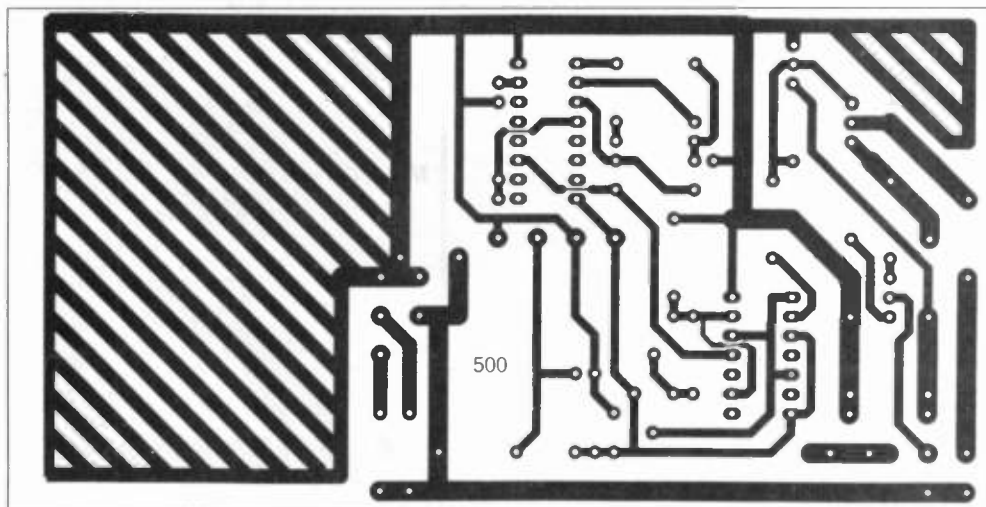
supply rail. If a larger transformer is used it may have to be mounted elsewhere, in which case separate earthing arrangements will be needed.

All the passive components should be fitted first. The electrolytics C2, C3 and C4 are placed horizontally, so a drop of glue

Fig. 4. Printed circuit board component layout, full size copper foil master and wiring details for the Timed NiCad Charger.



TP = TEST POINT



should be used to keep them secured to the p.c.b. D.I.L. sockets should be used to take IC1 and IC2, at this stage these and the three transistors should not be fitted.

Next, the p.c.b. should be powered up. A bench power supply can be used if available, it always feels safer when first powering a circuit if it can be done using a current-limited source.

There will be a surge of current as the electrolytics charge, following which the supply current, if this is being measured, will settle to about 8mA. This assumes that the main supply is around 20V, corresponding to the peak value from an unloaded 15V transformer. The 8.2V supply from Zener diode D4 should be checked.

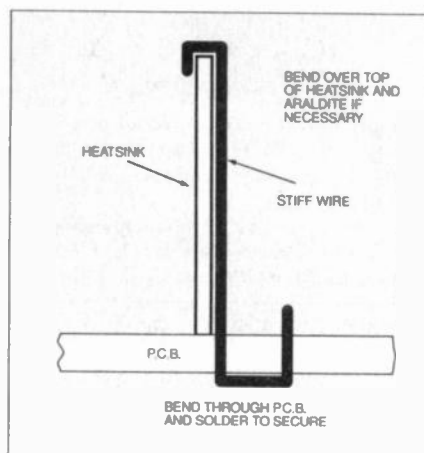


Fig. 5. Method of securing the "loose end" of the small heatsink to the p.c.b.

HEATSINK

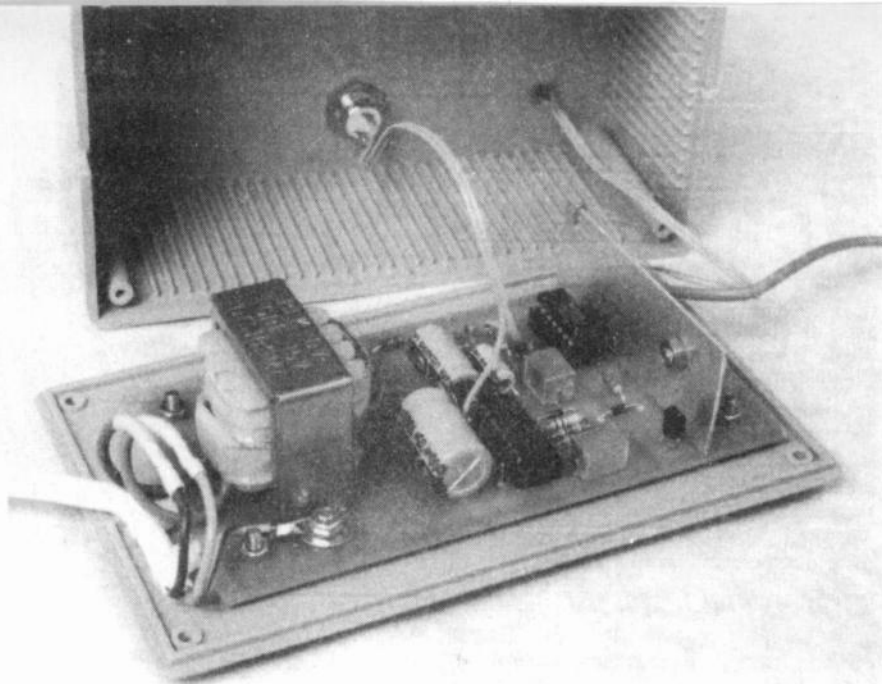
Following this, the three transistors should be fitted, together with the heatsink for TR3. For the basic AA-cell charger this can be a 25mm x 63mm (1in. x 2.5in.) piece of aluminium. A drop of heatsink compound under the tab of TR3 will aid heat transfer, and the end of the heatsink opposite the transistor can be supported with a piece of stiff wire soldered to the track provided and bent over the top. Fig. 5 shows how this is done. If there is any problem with rattles, a blob of Araldite will cure it.

The tab of TR3 is internally connected to its drain (d), so the heatsink should *NOT* come into contact with any other parts of the circuit. Of course, for higher current outputs, it may be necessary to mount TR3 elsewhere with a larger heatsink.

FUNCTION TESTS

The l.e.d. D10 should be connected, and two 330ohm resistors connected in parallel across the output to simulate the "load resistance" at normal charging current. A piece of very thin wire should be pushed into IC2 socket connections 9 and 14, to apply the 8.2V supply to the gate of TR3.

Power should be applied whilst monitoring the voltage across the "load", with luck the l.e.d. should light and the voltage should be about 10V, corresponding to a current of 55mA to 60mA. The load resistors may warm a little during this test. This completes checking of the output stage, although the load resistors and l.e.d. should be left in place for the next part.



Switch the supply off. Remove the wire link from IC2 socket and place it across the connections for pins 3 and 16 of IC1's socket. This will apply a high signal to pin 4 of IC2, which can now be inserted in its socket. If the circuit is powered again, the l.e.d. should flash briefly at two-second intervals, showing that this part of the circuit is operating.

Arrangements should now be made for briefly shorting the "start" switch S1 connections, and IC1 should also be fitted into its socket. On power-up the output state may be either continuous or pulsing, but shorting S1's connections should cause the l.e.d. to become continuously illuminated.

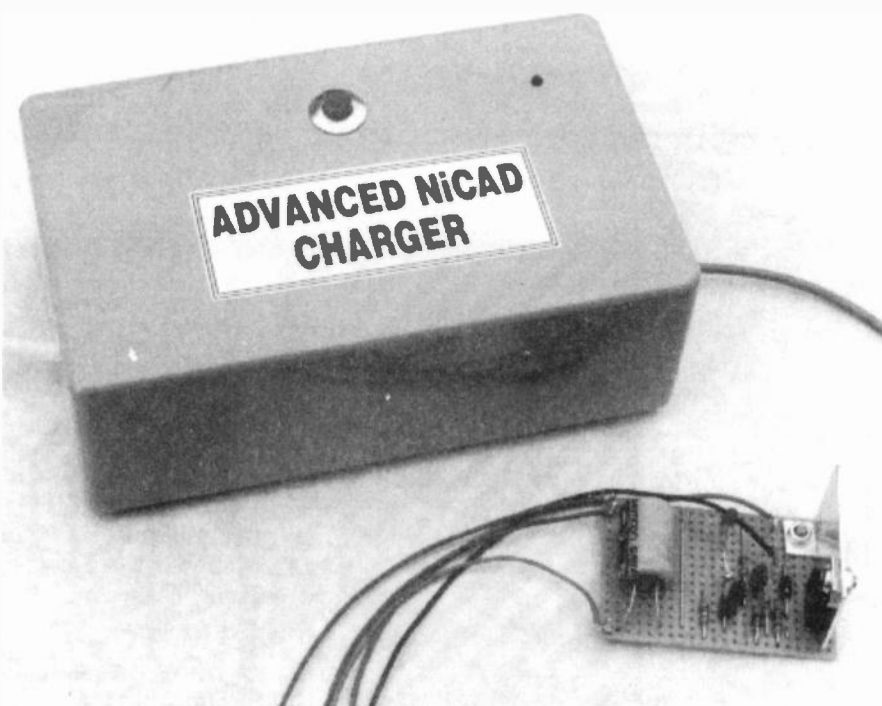
If the "Test Point (TP)", from pin 7 of IC1, is monitored, it should go low when switch S1 is shorted and high about fifty seconds after the short is removed. This will confirm that the oscillator is operating at about the right frequency. It is also

possible to monitor pins 9 or 10 of IC1 which should change state about every 3.5 seconds.

BOXING UP

This completes construction and testing and the unit can be fitted into any suitable case. External connections to the board are all as shown in Fig. 4. Connection to the battery can be made in any way the user chooses, though a PP3-type connector on a short lead is a good option as many battery-holders are fitted with connectors for these.

The p.c.b. can be used for the simple, non-timed, Constant Current version if required, all that is needed is to link the top of resistor R8 to the 8.2V supply, a good point for this being the point for pin 14 of IC2's socket. It would then be possible to upgrade the unit for timed operation at a later date.



Completed Timed NiCad Charger and Constant Current version.

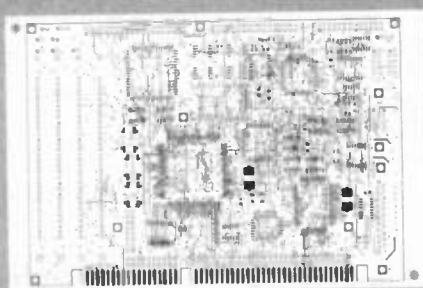
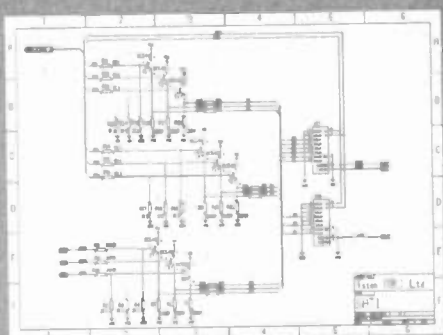
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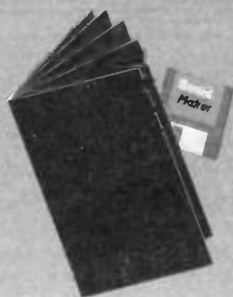
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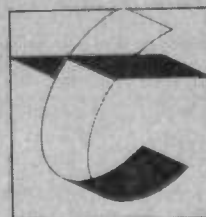
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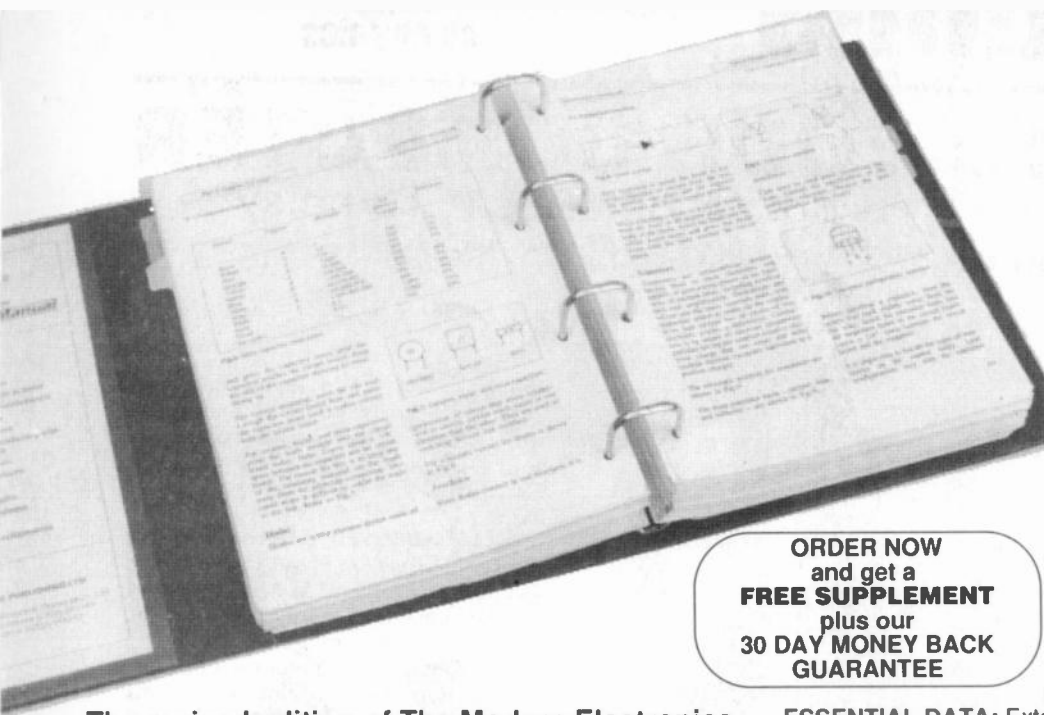
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TALKING TO YOUR COMPUTER

TalkMic lets your PC take dictation even in the noisy madding crowd – by Hazel Cavendish

VOICE recognition technology which enables people to talk to their computers has been an exciting idea for a long time, but one that has not quite gelled for universal use, up till now. Although there are a number of speech recognition programs available, they have either needed to be confined to markets where the vocabulary in use was fairly small, or have required extensive technical training for users. Most have run into snags, resulting in consumer disappointment.

Now a two-year collaboration between Responsive Systems, a London based company specialising in developing and marketing voice recognition systems, and Snap Labs, who are acoustics interface specialists, has resulted in a microphone breakthrough which has given the technology a new impetus.

They have introduced *TalkMic*, the first microphone to be specifically designed for voice recognition, and which works with an adaptation of the Kurzweil-Voice 2.0 system. The latter is the product of an American company which has made much of the running in the development of voice recognition.

GAINED IN TRANSLATION

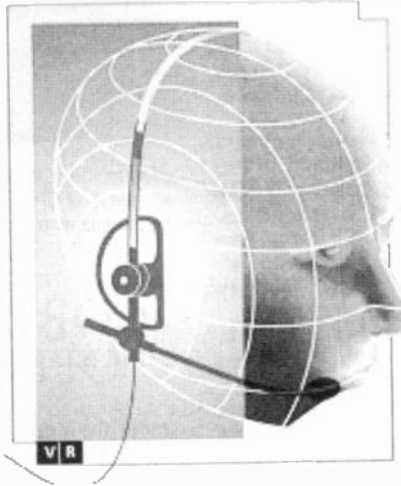
The system required modification to suit the UK business world and the American software has been rewritten by Responsive Systems, using language which is familiar to the British user. The firm received several hundred trade enquiries the day after the recent product launch and several thousand since then.

Responsive Systems originally set in motion a research programme to investigate omnidirectional, unidirectional and pressure gradient microphones. Experiments showed that even high quality unidirectionals could only be used in relatively quiet conditions. Conventional microphones often suffered from poor design and poor noise rejection.

The team recognised that the varying levels of background noise had proved to be a limiting factor for the wide acceptance of other voice response systems. In many office environments colleagues' conversations, telephone calls and general background noise ended up as words on screen. There was also a clear distinction between the acceptability of a microphone headset having an airline pilot image, and that associated with a hobbyist image.

NEW HEADSET SOLVES IT

Finally, a small pressure-gradient electret microphone was developed on an entirely new headset from a



company with over 20 years of experience in designing subminiature electret models. The TS024 microphone design was developed using an acoustic manikin, whose shape was generated from an average of 2,000 people to create a unique headset style, since pressure-gradient microphones must be used close to the lips in a relatively stable position.

The resulting *TalkMic* is similar to those used by sports commentators, pilots and the military, and is very responsive to sounds close to it, but virtually ignores those more distant – even if they are considerably louder. Its ability to separate the user's voice from environmental noises makes it the best option for communication clarity in any environment, whether typical office or busy production line.

In tests, recognition successes of 98 per cent were achieved regularly in a typical office, and with an experienced user 100 per cent recognition was achieved over several hundred words. Moreover, *TalkMic* is robust, has low sensitivity to user movement, accurately represents the voice over a wide frequency range, and offers a hands-free operation of keyboard or switchboard.

PHENOMENAL PHONEMES

The Kurzweil Voice system has a vocabulary of 200,000 words, and uses sophisticated language modelling techniques to recognise spoken words from their context in a sentence. It can take dictation at up to 60 words a minute, quickly adapting to a user's accent and pronunciation. It works with Windows 3.1 and Windows 95, plus a soundcard, usually *Soundblaster*. The software algorithm analyses the speech pattern and

splits it into individual sound patterns – phonemes.

"As a result of that analysis, you should have a list of phonemes which represent the word you have just spoken," says Robin Cameron, Responsive Systems' Product Development Manager. "That list is then passed to a look-up table of all the words which could match the sound. If the computer thinks it has got the word you have just spoken, it will put it on the screen, and supplies other words in a list called the Take List, just in case there is a mispronunciation and you need to make a correction. The machine soon learns to 'hear' the idiosyncrasies of the way you speak, and also has some idea of the whole word model.

"When it hears the word 'IT' the machine is not thinking of 'I' and 'T' but of the way you say the word – although it has a pretty good idea of what the word *should* sound like. When you start speaking into the mic you don't need to use a clipped voice, as some other systems require.

We have aimed at the user speaking naturally, by ensuring that the mic has a very broad frequency range, and that there is absolute consistency in its manufacturing standards. The system also tries to do a little bit of conjectural checking, so that when you say 'Ready to go' it knows which version of 'to' to put in – not 'too' or 'two' but 'to'.

DOCUMENT CREATION

"It is only with the advent of fast computers with a lot of memory that this sort of technology has become really viable. The beauty of this system is that it works quickly and is very accurate. It replaces a typist for a lot of people. It also has command sets with it, and it knows the difference between a command and a word that you are trying to put in your text.

If you want to delete four words, you simply say 'Delete four' and that command would generate key strokes to delete those words. It is possible to edit the text, colour it and format it. You can't call this a dictation machine; it is really a document creation technology."

"After a very brief initial training, which can be added to an application like Word 95, you can pick it up and get going very quickly. Because it is speaker-independent it very soon adapts to your voice."

Enquiries should be made to Responsive Systems Ltd., 34A Glazebury Road, London W14 9AS. Tel: 0171 602 4107.

Yeda Glory for EPE Contributor

You've all been following the *Teach-In '96* series and its associated constructional projects haven't you? And you will have noticed that as well as Max Horsey being credited as the author, other names have been credited for the printed circuit board designs. Max Horsey is the Head of Electronics at Radley College near Abingdon in Oxfordshire; the p.c.b. designers are his pupils.

Well, we are delighted to announce that two of Max's students, Christopher Caulkin, aged 15, and James Anderson, aged 14, have won prizes in the 1996 Young Electronic Designer Awards (YEDA).

Chris Caulkin has actually won two levels of recognition: The Texas Instruments' Prize for *The Most Commercially Viable Project*, and he came first in the Intermediate Category for 15-17 year olds. The design which attained him both honours was a Microcontroller-based

Sunbathing Warning Device. The TI Award is worth £2500 and is shared by the College and Christopher. The YEDA Trophy and £750 was the First Prize in the Intermediate Category. Chris designed the p.c.b. for the *Event Counter* in our April 1996 issue.

James Anderson came third in the Junior Category with his Finder Unit to Aid the Blind, winning £150.

All finalists also received a Texas Instruments' T180 Graphics Calculator, a YEDA sweatshirt and a certificate. The winners in the three age categories also received an Echo Pager from Mercury MiniCall.

We send our warmest congratulations to Chris and James. Well done! Congratulations, too, to Max who is obviously teaching his students well and with enthusiasm.

Still thinking of Awards, something of a coincidence has happened and which is of immediate relevance! Back in 1987, a certain Jeremy Sidons became a prize winner in the Young Engineer for Britain Competition with his Digital Transistor Analyser. In our next issue, August '96, we are publishing his updated version of that design, the *Component Analyser*. This design analyses and provides information about bipolar transistors, diodes and l.e.d.s. In addition, it also produces test tones for speakers and can check circuit continuity.

The YEDA scheme is open to students between the ages of 12 to 25 in secondary schools, colleges and universities. For more information, contact The YEDA Trust, 24 London Road, Horsham, West Sussex, RH12 1AY.



Christopher Caulkin, YEDA prize winner and EPE contributor, with his award winning design.

CORDLESS OFFICES

Under the new telecommunications regulations which recently came into effect, companies can now make use of cordless telephone technology in offices and business premises. This ability will give more flexible communications and remove the need for expensive cabling.

It means that staff can carry their telephone extensions throughout their own business premises and make and receive calls by radio and without cables.

The Cordless Telephony Apparatus Exemption Regulations allow companies who provide their own systems to use European harmonised Digital Enhanced Cordless Telecommunications (DECT) equipment without a Wireless Telegraphy Act 1949 license. They also consolidate previous cordless telephony regulations.

The DTI (Department of Trade and Industry) say that for more information you should ring 0171 211 0211.

EPE PIC PROGRAMMER

Lots of you will be interested to know that some new files have been added to the software disk available for the *Simple PIC16C84 Programmer* that was published in our Feb. '96 issue. The files allow readers to disassemble a hex dump of the object code (.OBJ) created by Darren Crome's original software.

This disassembling software has been kindly made available to us by Nigel Goodwin. Those of you on the Internet might also be interested in making yourselves known to Nigel at <nigelg@lpilsley.demon.co.uk>. He seems to be very well-acquainted with microcontroller programming.

The cost of the new software disk is a nominal £2.50 (UK cost), just to cover our admin costs (the software itself is free). For convenience, all the previous *PIC16C84 Programmer* files are on the disk. So too is the *PIC-Electric Meter* (Feb. '96) software, plus that for *PulStar* (June '96) and the *Games Compendium* in this July issue.

Not only that, we've now added in the *EPE Met Office* (Dec. '95) software as well. What a bumper bundle for just £2.50. For overseas readers the cost is £3.10 surface mail, £4.10 airmail. There are no refunds for sending your original PIC disk back - as if you'd try it ...!

Hot Dignity!

Digital and analogue chips don't normally like the heat and can suffer worse than exhaustion if subjected to it. So, if you think your chips might be in danger of over-frying, how about keeping a watchdog eye on them using the new MicroCelsi temperature recording labels from Spirig?

The labels are designed to sit piggy-back on i.c. packages and act as watchdogs for hours, days, weeks or even months and reliably record the maximum temperature levels reached in that period at that spot. Such a technique can obviously be of great benefit for chips in enclosed cases. In such situations, opening the case to take conventional measurements can cause drastic temperature changes which make readings meaningless. With MicroCelsi labels in use, however, observations can be taken at any time without affecting the label display.

Ask your local components stockist for more information about Spirig's MicroCelsi labels.

Hotter Still!

Power from the sun will be brought to more people around the world through the first photovoltaic (PV) test centre in the UK, which was opened recently by Junior Energy Minister Richard Page. Photovoltaic materials are usually solid-state semiconductors which generate electric current when exposed to light.

Supported by the DTI, the centre at Eversley, Hampshire, is being developed by IT Power, one of the world's leading renewable energy consultants. Staff from developing countries will be trained at the centre in the effective use of PV equipment, particularly where they are bringing electricity to remote communities for the first time. It will also test and certify PV panels.

"Photovoltaics has the potential to provide a sustainable and pollution-free energy source for meeting our future energy needs", commented Richard Page. "For example, the project at the University of Northumbria shows that office buildings in the future could generate about one-third of their energy from PV. Thousands of solar devices are used in this country, powering navigation lights, traffic counters and weather stations", he added.

Where it's at

July 14, Sunday. The 16th Sussex Amateur Radio and Computer Fair at Brighton Racecourse, from 10 a.m. to 4 p.m., only £1.50. Free car parking and a picnic area. This rally is one of the largest in the South of England with well over 100 Trade stands and a Dedicated Room for Bring and Buy, with over 40 feet of display area, plus refreshments and bars at reasonable prices. Tel: 01273 501100.

Aug. 11, Sunday. The 39th Derby Mobile Rally takes place at Littleover Community School, Pastures Hill, Littleover, Derby, opening 9.30a.m. The School is located off the A5250 (Burton Road) south of Derby, one mile south of Littleover and the A5111 Derby Ring Road. There is a large flea market, a wide range of radio and computer traders, plus a monster radio and computer "junk" sale. Refreshments available. Tel: Martin Sharlow, 01332 556875.

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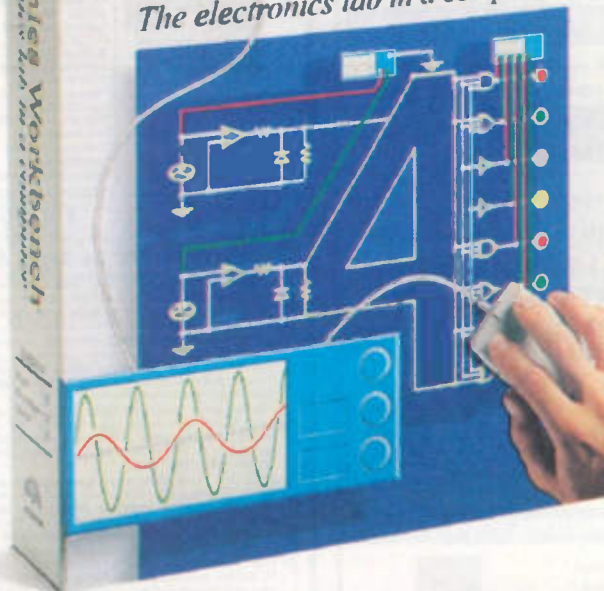
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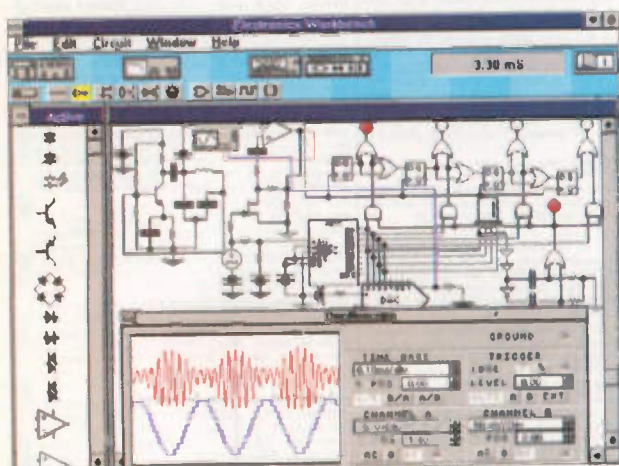
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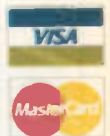
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STAIRWAY TO HEAVEN GAME This game of skill tests your hand-eye co-ordination. If you press the switch each time the green part of the pole LED lights up, climb higher up the stairway - but miss & you start again! Introduces you to several basic electronic circuits. Box provided. 9V operation. 78x50x19mm. Roile Harris NOT included! 3005-KT £8.95

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SHOP

TALK

with David Barrington

Advanced NiCad Chargers

The *n*-channel MOSFET type IRF630 called for in both the *Constant Current Charger* and the *Timed NiCad Charger* should be available from most of our component advertisers. But if any readers experience difficulty with this device it can be purchased from **Maplin**, code UR44X.

Starting with the *Timed* version first. A suitable miniature 100mA mains transformer should be readily available, and one with wire-ended leads is preferred here as the connecting pin spacing on a direct mounting p.c.b. type becomes critical.

If a higher rated or larger mains transformer is used in this project it is most likely that it will need to be mounted off-board, in which case separate "earthing" arrangements will be needed. This can be a simple link lead from the p.c.b. to one of the transformer mounting lugs, which also anchors the mains input Earth lead.

If possible, the pushbutton switch should be the "shallow" bodied type so that it does not short on any of the circuit board components. When ordering the BC184L transistors (for both versions) be sure to quote the suffix L as other versions of the device have different pinouts.

All components needed to build the *Constant Current Charger* are standard "off-the-shelf" items and should not cause any sourcing problems.

Single-Station Radio 4 Tuner

The two 4.7mH inductor coils required in the *Single-Station Radio 4 Tuner* are manufactured by Toko of Japan. These were obtained from **Cirkit** (Tel: 01992

448899), their UK distributor, and came from the 10RB range, code 34-47202. They also supplied the 5pF to 60pF foil trimmer capacitors, although suitable types should be generally available.

It is important, in this case, to note that the transistors TR2 and TR3 *MUST* be BC184 types *without* prefix L as, once again, the pinout arrangements differ. Also, note that the pins for the 2N3819 *n*-channel f.e.t. are not arranged in a triangular formation but are in-line. This means you will have to carefully bend the centre gate (g) pin out to its copper pad on the p.c.b.

The mains transformer is a 3VA type, with a 20V-0V-20V secondary, and was chosen to sit directly on the p.c.b. The one used in the model is an RS type and was purchased through **Electromail** (Tel: 01536 204555), code 207-857.

Choice of case is left to the constructor, the one used in the prototype is a Vero 75-2861D box.

Twin-Beam Infra-Red Alarm

For the Transmitter and Receiver models that make up the *Twin-Beam Infra-Red Alarm*, this month's *Teach-In* project, a TIL38 high power IR emitting diode and TIL100 photodiode were selected. If possible these should be purchased as a pair, the ones used in the prototypes came from **Maplin** and are listed as direct equivalents, codes YH70M (TIL38) and YH71N (TIL100).

The UM3750 encoder/decoder and the special infra-red preamplifier TBA2800 also came from the same stockist. These are coded UK77J (UM3750) and JU36P (TBA2800).

Games Compendium

With the choice of a pre-programmed PIC or a source code disk, no component sourcing problems should be encountered by constructors of the *Games Compendium* project.

A ready-programmed PIC16C84 is obtainable from the designer, John C. Barker, for the sum of £12 plus £1 for post and packing. Overseas readers should add £2 to their order. He is also willing to program any 16C84 chip sent to him for the fee of £3.50 plus £1 p&P (£2 overseas).

All orders should be sent to: **Mr John C. Barker, 19 Mallard Way, Morley, LS27 8EY, Make cheques payable to: John C. Barker.**

For those who wish to program their own chips, the source code is available on 3.5in. disk from the Editorial office for the sum of £2-50 (Overseas - surface £3-10; airmail £4-10).

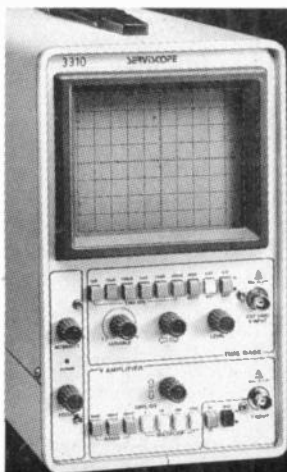
This file must be compiled to an object code file (.OBJ), which then needs to be downloaded into the chip using a suitable programmer, such as the *Simple PIC16C84 Programmer* in *EPE* Feb. '96 issue. (Now Sold Out! see page 548).

Frequency Generator and Counter

All the "special" components for the *Ultra-Fast Frequency Generator/Counter* were covered in last month's *Shoptalk*.

A minor problem has arisen regarding the specified case. It is no longer stocked by the original source and, to date, one with identical measurements has not been forthcoming. However, provided the height of 100mm or greater is adhered to, almost any plastic case (with a metal front panel) can be used. You could, if you wish to "lash-out" about £25 to £30, go for a slightly larger (RS 221-027) version.

All the r.o.b.s for this month's projects are available from the *EPE PCB Service*, page 571.



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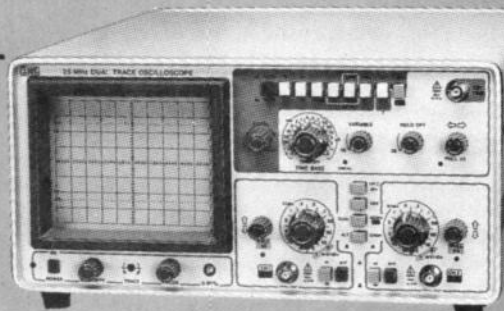
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MORE SCOPE FOR GOOD MEASUREMENTS

ROY BEBBINGTON

Part 2

You can really see what is happening inside electronic circuits if you know how to look properly.

IN THE previous article last month, the basic design functions, controls and measuring facilities of a typical analogue oscilloscope were discussed. However, there is nothing like hands-on experience to bring home to scope users the practical implications of such adverse effects as loading, mismatch and phase shifts, which can falsify measurements or lead to inaccuracies.

Here in this concluding article a look is taken at a few practical experiments that will help you to avoid some of the common pitfalls. Finally, we shall examine the basic principles of storage scopes.

INPUT COUPLING

If you are interested in viewing an alternating current (a.c.) signal that is superimposed on a direct current (d.c.) level you will probably want to use the AC Input Coupling mode, especially if the d.c. level is high compared with that of the a.c. signal. Switching to AC Coupling connects a capacitor in series with the input signal, which blocks the direct current, but passes the alternating current. The effect of the DC-0-AC switch is shown in Fig. 11.

The central horizontal graticule line can be used as the zero volts reference if desired by selecting the 0-Coupling position. This switch position disconnects any input signal and connects the Y amplifier input to ground. The resulting horizontal line can then be shifted by the Y POS control as necessary to represent the zero reference line.

In the DC position, the superimposed a.c. signal is offset towards the top of the screen, demonstrated by a 3V battery connected in series with a small a.c. signal. If the battery is reversed, then the offset will be towards the lower half of the screen.

Switching to the AC Coupling blocks the d.c. level and the a.c. signal can be centralised with the Y POS control around the zero reference line.

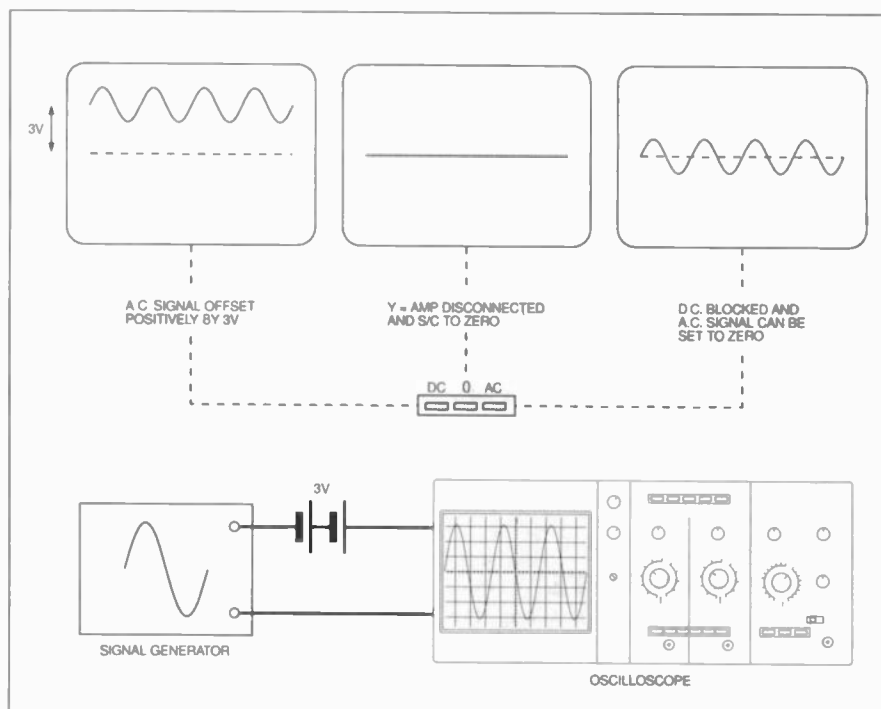


Fig. 11. Effect of input coupling on an a.c. signal superimposed on a d.c. voltage.

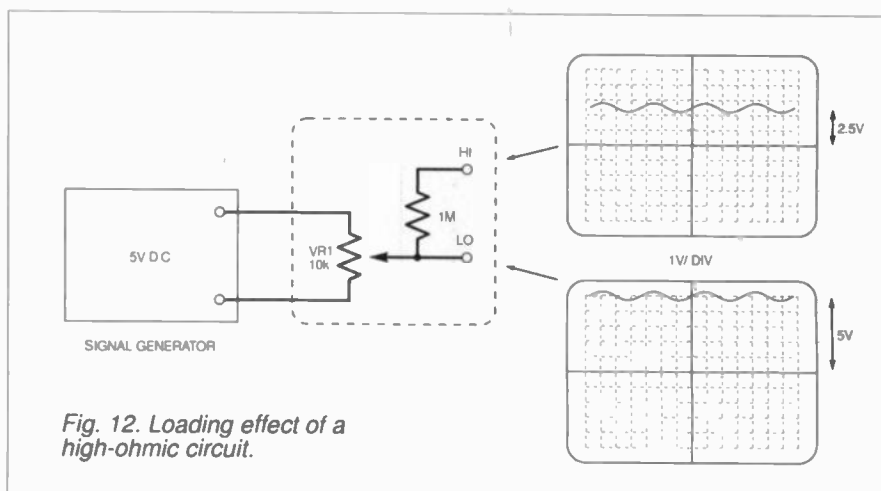


Fig. 12. Loading effect of a high-ohmic circuit.

LOADING EFFECTS

As previously stated, measurement inaccuracies occur if the measuring source impedance is high compared with the input impedance of the scope. The same is true, of course, with respect to measurements made in high impedance circuits with the humble voltmeter. A circuit is "loaded" by a measuring device of comparable impedance, as we shall see.

The 5V d.c. power supply source in Fig. 12 is varied by VR1, a 10 kilohm (10k) potentiometer. If the scope input is taken from the low-ohmic (LO) output, the wiper of the potentiometer, the screen deflection is five divisions. However, the high-ohmic (HI) output via the one megohm (1M) source resistor gives a half voltage reading (2.5 divisions) because the source impedance is effectively the same as the scope input impedance (usually 1M). The voltage at the scope input is calculated as:

$$V = (R_{in} \times V_s) / (R_s + R_{in})$$

where:

R_{in} = scope input impedance

V_s = source voltage

R_s = source impedance

The moral is to keep the source impedance small. Moreover, use coaxial cable rather than plastic-covered cable to avoid hum. In high-ohmic situations, a 10:1 passive probe would give an input impedance of 10 meg. (10M). This probe would also give improved results in a.c. measurements where stray capacitances produce heavy loading effects; coaxial cables account for about 100pF/metre.

Pulse waveforms contain high harmonics and the coaxial cable must be capable of transporting these harmonics without loss from the pulse generator to the scope input. Most pulse generators have an internal impedance of 50 ohms, which matches the characteristic impedance of the cable. Likewise, to avoid mismatch errors, the oscilloscope side of the cable should be similarly terminated in 50 ohms, not merely by its 1M input impedance.

PHASE MEASUREMENTS

The early method of measuring the phase relationship between two waveforms was by applying one signal to the Y input and the other to the X input (X DEFL connector with timebase turned off). Depending on the phase angle between the two signals, this method produces the traces displayed in Fig. 13, referred to as "Lissajous Figures". Note that the X and Y signals have, or are arranged to have, the same amplitude on the screen to obtain a true circle when 90° out of phase.

The manner by which Lissajous signals can be created using two signal generators is shown in Fig. 14.

With dual-trace oscilloscopes, phase differences in sinusoidal waveforms can easily be observed by applying one waveform to the YA input and the other to the YB input. By means of the shift controls (Y POS) these should be aligned along a common X-axis. A simple set-up is given in Fig. 15 for demonstrating this effect between two sinewaves created from a single source, but with one phase-shifted in relation to the other.

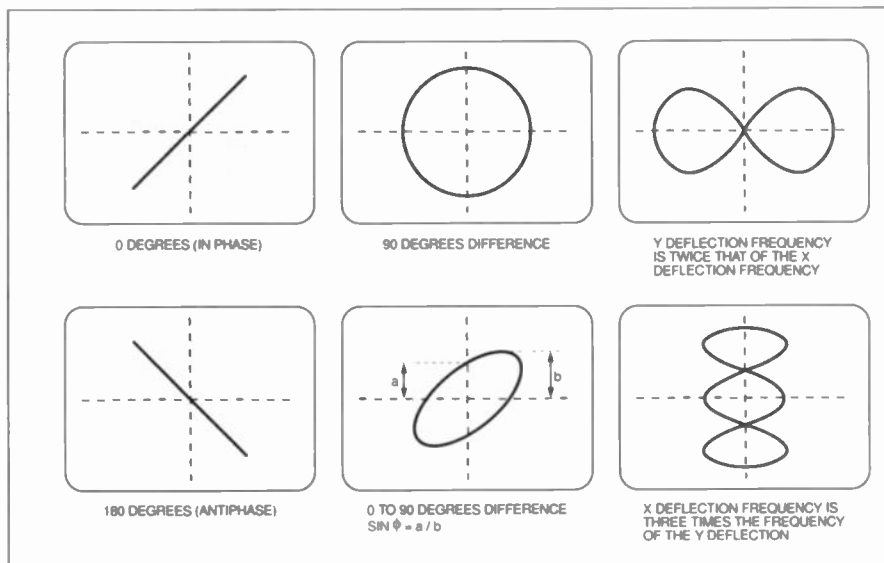


Fig. 13. Idealised screen graphs of "Lissajous Figures" showing phase relationships of two signals.

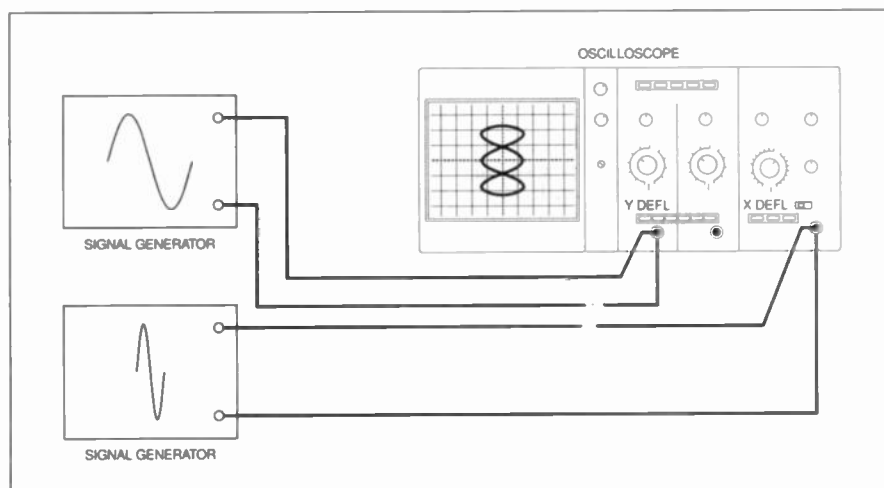


Fig. 14. Using two signal generators to create Lissajous Figures.

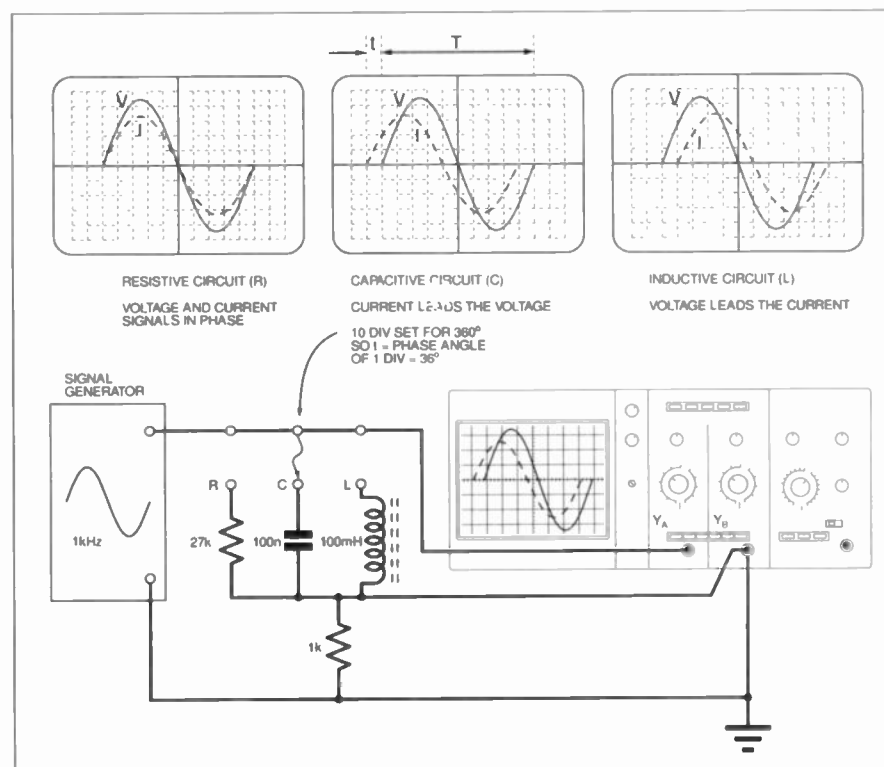


Fig. 15. Phase measurements for resistive, capacitive and inductive circuits.

Input YA measures the total voltage across the two components of the chosen circuit combination, while YB measures the voltage across the lower (1k) resistor, which is in phase with the current through the combination. With the resistive circuit (R), the voltage waveform at the YA input is in phase with the current waveform at the YB input; i.e. there is no phase shift in a purely resistive circuit.

In the capacitive circuit (C) it can be seen that the current waveform leads the voltage waveform and, conversely, in the inductive circuit (L) the voltage leads the current waveform. The value of the phase angle can easily be calculated from its tangent:

$$X_c / R$$

where X_c = reactance
and R = resistance

In the capacitive circuit, if the frequency is 1kHz and the capacitor value is 0.1µF (100nF), then its reactance ($1/2\pi fC$) will be 1600Ω (1k6Ω). With the series resistor of 1kΩ, this gives a tangent of 1.6, which corresponds to a phase angle of about 54°.

PRACTICAL PROOF

You can easily prove most of these experiments with signal sources readily available, such as batteries for d.c. checks, the built-in calibrator for square wave checks, and mains hum, ever present when you put your finger on the open-circuit Y input socket of a scope. However, you may not have an audio sinewave generator handy for phase measurements, so here is a useful oscillator circuit that can be used as a sinewave source, as well as providing other interesting display features to observe on your scope.

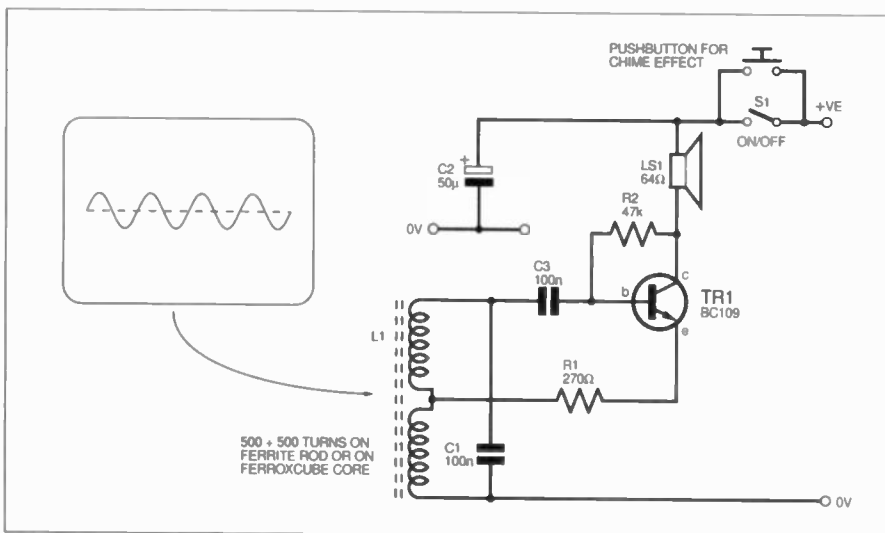


Fig. 16. Practical circuit diagram for a Hartley oscillator for a sinewave signal.

The Hartley oscillator circuit shown in Fig. 16 has been widely used in the past as an electronic organ generator, especially in percussion circuits because of its good stability. Note that the on/off switch is paralleled with a pushbutton switch.

If you leave the on/off switch open and press the pushbutton momentarily, the note will sound and then decay with a bell-like tone as the supply voltage is removed.

Connect the scope input leads across the coil L1 and you will observe a sinewave, which collapses slowly to a straight line without any horizontal movement i.e.

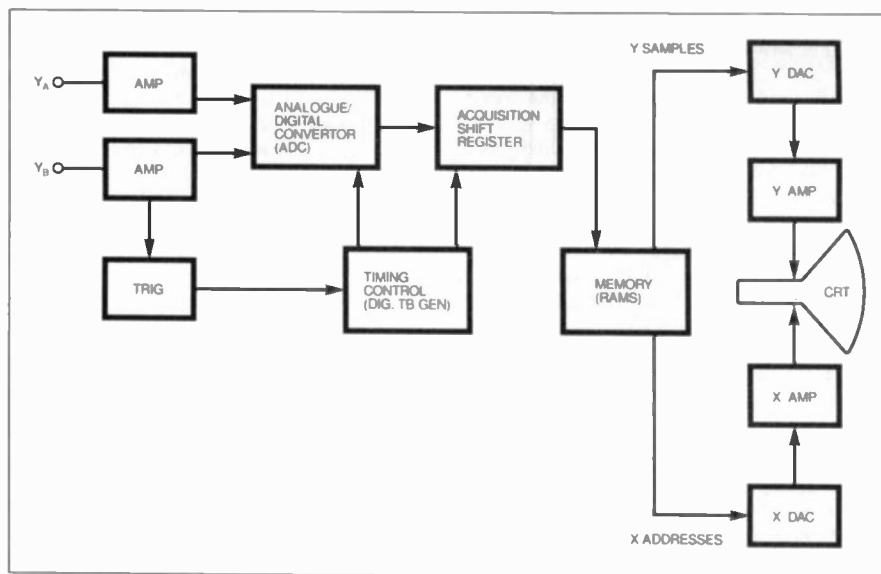


Fig. 17. Simplified schematic block diagram for a two-input Digital Storage Oscilloscope.

without a change of frequency, when the pushbutton is released. The sinewave collapses slowly because, when the supply voltage is removed, the energy stored in the electrolytic capacitor C2 continues to supply the collector voltage for a second or two, resulting in the chime sound.

With the coil L1 made using about 1000 turns of fine enamelled copper wire, wound in the same direction on a ferro-cube core or piece of ferrite rod and centre-tapped, a parallel capacitor, C1, of 100nF will tune the frequency to about 1kHz.

At a TIME/DIV setting of 0.1ms/div a complete sinewave period of 360° should

flute sound via a resistor. For string, brass and woodwind sounds try feeding out from the transistor's collector, or the emitter. Plenty of scope for experiment!

WHAT'S IN STORE?

So far, the discussion has related generally to the use of analogue oscilloscopes. Time now to take a look at the merits of storage scopes.

A simple repetitive signal can be easily viewed on the conventional analogue scope so why do we need storage scopes, and why digital storage?

People in general, and service personnel in particular, have a dislike of being reduced to soulless numbers. Why, then, should anyone want to convert curvaceous analogue traces on a scope to cold, calculating digits?

Remember, though, that the persistence of the phosphor in a normal oscilloscope is less than a millisecond. As mentioned previously, analogue storage scopes are available that give a longer degree of persistence, but the special tubes are expensive. For really long-duration signals, and those that occur only once, single-shot signals, or infrequent signals, some permanent method of capturing and retaining is necessary.

Digital Storage Oscilloscopes (DSOs) enable each spot on the picture trace to be defined as a particular value (like painting by numbers!) and stored for all time in a memory. Digital can be forever, and there are other advantages:

- Unlimited storage of waveforms on disk, plotter, printer or computer for further analysis
- Pre-trigger information can be easily displayed/stored
- Fully automatic measurements are possible
- New waveforms can be compared with stored reference waveforms
- Peak detection circuits enable glitches (fast transients) to be captured
- Mathematical processing of waveform information is possible
- Excellent picture quality with low-cost c.r.t.

DSO BLOCK DIAGRAM

The simplified block diagram of Fig. 17 shows the main functional circuits of a digital storage scope. The analogue input signals applied to the A and B Channel amplifiers are converted to digital form in an analogue-to-digital converter (ADC) and held in an acquisition memory, a digital shift register for transfer to storage and display memories (RAMs).

A digital timebase (TB) generator controls the sampling rate. The Y samples and X addresses are routed to Y and X digital-to-analogue converters (DAC) respectively, to reconstitute the display on the cathode ray tube.

DIGITAL STORAGE PRINCIPLES

The simplest way to capture an analogue signal and change it to digital form is to use an ADC. But, this is less simple when the analogue signal is oscillating at a high rate.

As shown in Fig. 18, the signal has to be sampled at regular intervals to determine its instantaneous value. Unfortunately, the values that fall in between these samples are not recorded and slight deviations in detail may be missed at very high speeds. Obviously, as indicated, the more samples taken, the better the picture.

In the storage section, represented in Fig. 17, the ADC consists of an array of comparators which respond to these instantaneous samples and generate binary words to represent each voltage. These are passed to a digital shift register by the acquisition control logic. The sampling rate is determined by the sample clock, usually ranging from 20 to 200 megasamples per second.

Typically, the shift register will have a capacity to store word samples (i.e. converted analogue values) which represent a complete screen of 10 vertical standard graticule divisions. Quite likely this may be 256 samples. When the shift register is full, the control logic stops generating clock pulses and the contents can be copied into the digital memory (RAM – Random Access Memory).

SAMPLING TECHNIQUES

For capturing high-speed waveforms, a technique known as *repetitive sequential sampling* is used, as portrayed in Fig. 19. In this technique, one sample is taken per horizontal trace, the time interval between triggering and sampling being slightly increased so that a waveform is reconstructed sequentially over a number of signal passes.

Random sampling is used when it is necessary to sample only the areas of interest. This enables fast waveforms, such as rise-times for example, to be thoroughly sampled and other inputs ignored. The sampling frequency is fixed, but as the circuit waits for new trigger events the trace is built up from clusters of samples randomly positioned, which can give greater detail.

Lower frequency signals can be captured and stored in memory using the Roll mode. In this mode, the waveform

rolls slowly from left to right across the screen, acting like a line recorder. Time-base speeds of up to one hour per division can be used to capture slow events. This mode can provide "baby-sitting" facilities for very long periods, especially if the DSO is interfaced to provide a computer or hard copy output.

C.R.T. DISPLAYS

The digital information for the Y parameters (vertical/amplitude data) and stored in RAM, has to be converted back to an analogue voltage for outputting to the c.r.t. This is done by a digital-to-analogue converter.

The memory addresses for the Y parameters each correspond to a specific point along the X-axis, i.e. the horizontal/time displacement factors. These addresses are fed to the X-DAC to provide the X-axis control voltage for the display.

Some DSOs may feature four memories, each capable of storing one or two input signals. This enables up to eight traces to be displayed simultaneously for comparison – one trace per vertical division. In a four-memory scope, each memory normally contains data for two vertical divisions. In such a scope, the display area consisting of two vertical and ten

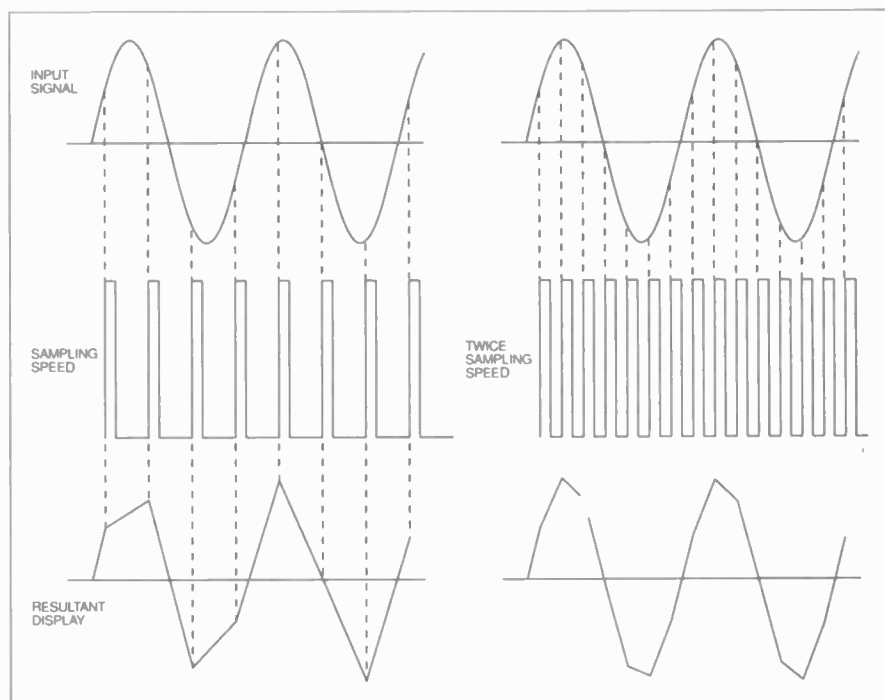


Fig. 18. A faster sampling speed results in a better display.

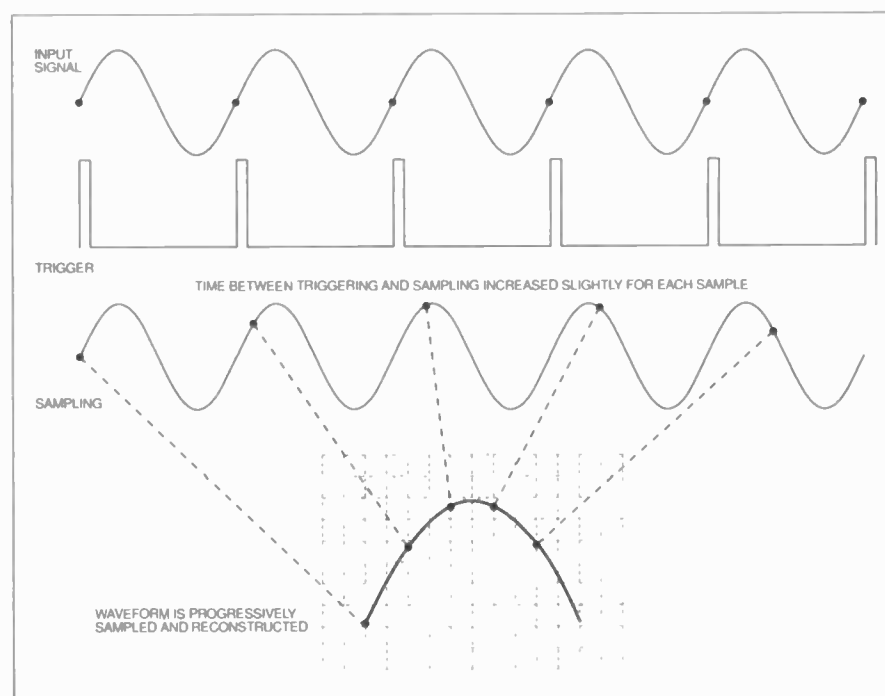


Fig. 19. "Repetitive Sequential Sampling" is used for high-speed capture.



Fluke 105 Series II ScopeMeter combined DSO and multimeter (from £879).

horizontal divisions might be made up of 256×256 dots; i.e. a dot density of 3276 (65536 / 20) samples per square division, as shown in Fig. 20.

In the $Y \times 5$ mode, the display area is expanded to occupy the whole screen, 10×10 divisions for the 256×256 dots. The Y sample information is passed to the Y DAC to provide the Y analogue deflection signal for display on the c.r.t.

LIQUID CRYSTAL DISPLAYS

Recently, DSOs have been produced using liquid crystal displays (l.c.d.s) in

DO'S AND DON'TS

To round off this article with a bit of good advice, when using an oscilloscope always remember the following points:

DO ensure that the vertical gain and variable time/cm controls are placed in the calibrate (CAL) positions before making measurements based on the attenuator/timebase settings and graticule.

DO ensure that you have the correct trigger source selected for the type of waveform under investigation.

DO remember to align the trace with the horizontal axis of the graticule with the input selector set to GND before making measurements of d.c. levels.

DO make use of the built-in calibrator facility, if available.

DO use a properly compensated oscilloscope probe.

DON'T leave the intensity control set at a high level for any great length of time.

DON'T leave a bright spot on the display for even the shortest time (this may very quickly burn the screen's phosphor coating).

place of the conventional cathode ray tubes. These displays use far less power and, as opposed to generating light, the l.c.d. simply controls it.

An l.c.d. consists of a liquid crystal compound sandwiched between a transparent array pattern formed by numerous metal electrodes. When an a.c. voltage is applied, and in suitable lighting conditions, these patterns (a dot-matrix for

scopes, segments for alpha-numeric displays) appear as a dark area against a silver background.

Together with large-scale integration techniques, l.c.d.s offer an ideal solution for portable instruments. The Fluke ScopeMeter is a good example, combining a 2-channel 50MHz DSO and digital multimeter in a battery-powered, handheld unit with provision for a printer output.

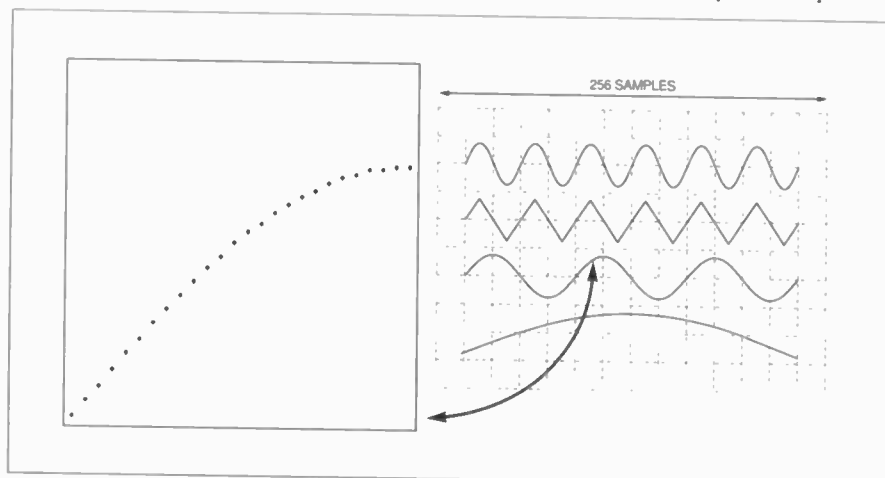


Fig. 20. Four-trace display showing the dot density.

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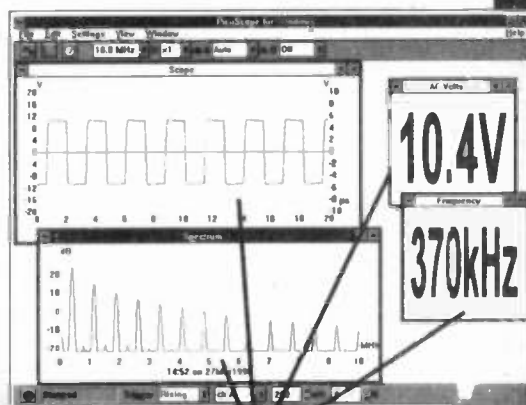
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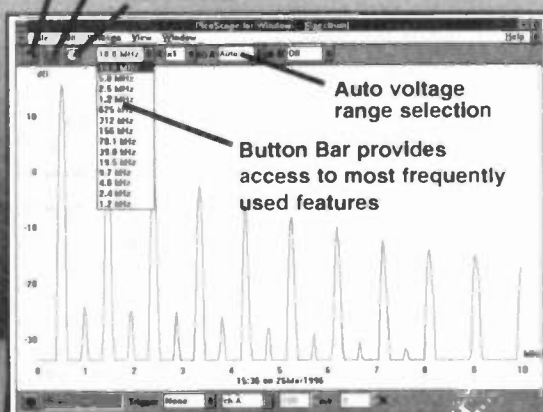
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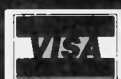
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JOHN LINSLEY HOOD

A black and white illustration of a cricket player in batting stance, wearing a helmet, pads, and gloves, holding a bat. He is sitting on a wooden crate in front of a kitchen stove.

Everyday Practical Electronics, July 1996

practice, between a ferrite rod, as used in the average portable transistor radio, and a simple aerial wire.

Advantages of the ferrite rod aerial are that it is compact, and avoids the need for external wiring. Its snags are that it is sensitive to its angular position and that it would prevent the whole unit from being enclosed, if needed, in a metal box – which would screen the aerial as well as the other circuitry. On balance it was felt that a simple wire aerial would be easiest to use.

SELECTIVITY

One of the problems in any AM radio receiver is in preventing breakthrough from radio transmissions on adjacent frequencies. The ability of a tuned circuit to select one particular frequency is determined by what is known as its *Q* (which stands for "quality factor"). The higher the *Q*, the more sharply tuned the circuit will be, and the better the rejection of adjacent channel signals.

Unfortunately, all radio broadcasts carry the modulation – the programme material – on a spread of adjacent signal frequencies, known as "sidebands". In the case of an AM (amplitude modulated) signal a broadcast audio bandwidth of up to, say, 5kHz (which is all that European AM stations are now permitted to transmit) would require a receiver bandwidth of $\pm 5\text{kHz}$ on either side of the tuned frequency. The formula: $\text{Bandwidth} = f/Q$ defines the audio bandwidth between the -6dB points on the selectivity curve on either side of the transmitter frequency.

For a tuned frequency of 198kHz this would imply a desired circuit *Q* value of a bit less than 20. Since the *Q* of the specified Toko 4.7 millihenry inductors, when tuned with a parallel capacitance of about 135pF, is around 50, some additional damping resistance is needed to reduce the sharpness of the tuning, and prevent too much loss of the higher modulation frequencies. In practice, a 220 kilohm resistor in parallel with the tuned circuit gave about the correct bandwidth on the prototype receiver.

RECEIVER CIRCUIT

The final circuit diagram for the Single-Station Radio 4 Tuner is shown in Fig. 2, apart from the nominal 22V power supply, which is shown in Fig. 3. The aerial wire is directly connected, via SK1, to the input tuned circuit (coil L1 and capacitors VC1 and C3) via a small value capacitor C1. The second tuned circuit (L2, VC2 and C8) is similarly connected to the output from transistor TR2.

The output from transistor TR3 – about 50,000 times bigger than the aerial input signal – is taken to the op.amp demodulator IC1a and also, via capacitor C9, to the "diode-pump" circuit D1/D2. The "pump" is used to generate a small negative a.g.c. (automatic gain control) voltage. This will help to minimise the effects of fading, and reduce the influence of the length and position of the aerial wire.

For any AM signal to be audible, the modulation must be separated from the "carrier". This is done, most easily, by simply rectifying the incoming signal, but, if a small-signal silicon diode is used as

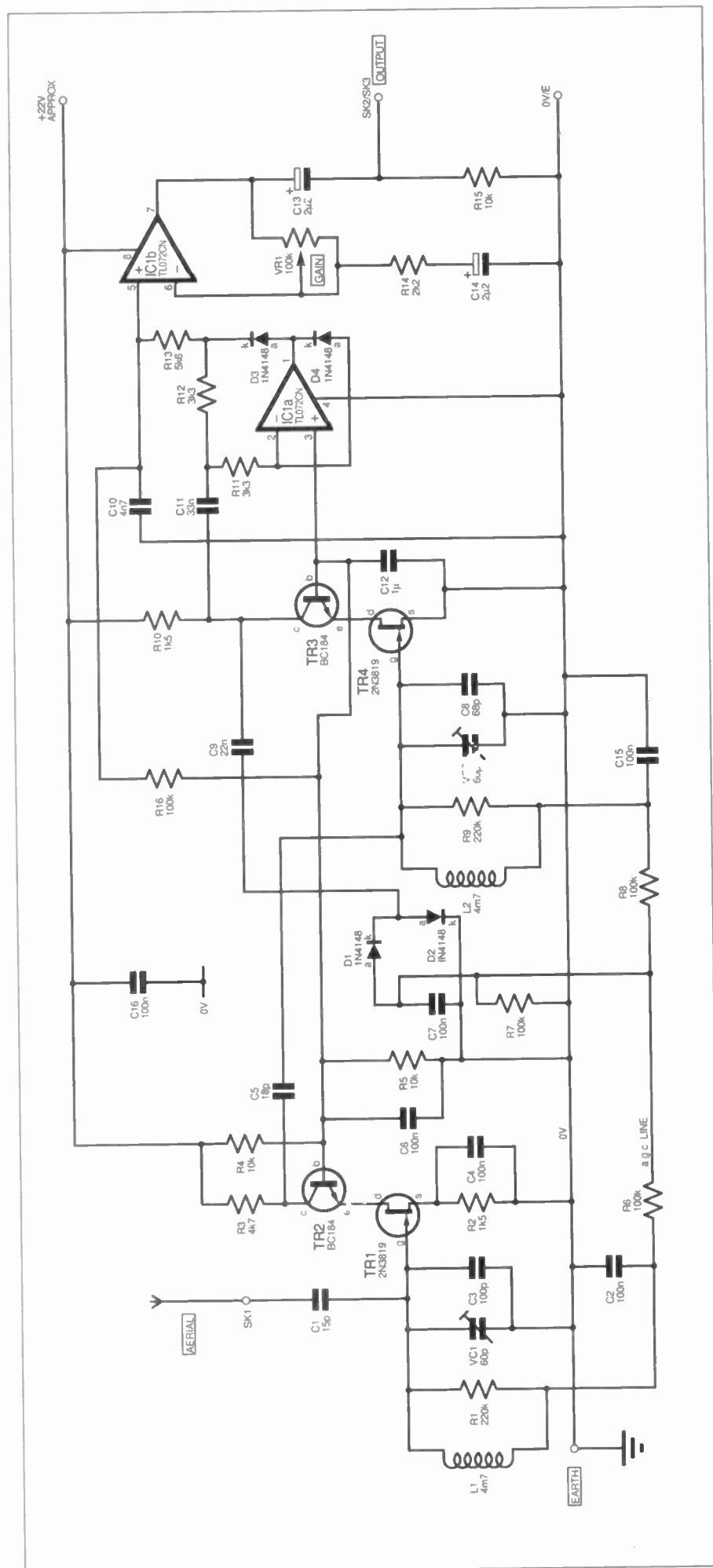


Fig. 2. Full circuit diagram, except power supply, for the Radio 4 Tuner.



The completed Radio 4 Tuner prototype.
The panel fuseholder is not shown on this model.

the rectifier, it will not work very well on input voltages less than some 0.5V peak. However, if a pair of diodes are hooked round an op.amp, IC1a, as shown in Fig. 2, the rectification threshold is reduced to a few millivolts, which increases the demodulator sensitivity by a few hundred times.

The other half of the dual op.amp, IC1b, is a straight a.f. amplifying stage, whose gain is adjustable by the potentiometer VR1. Resistor R13 and capacitor C10, on its non-inverting input (pin 5), act as a simple r.f. filter to remove any residual 198kHz signal voltage from the audio output.

Resistor R16 serves to prevent the non-inverting (pin 5) input of IC1b from wandering about, in the absence of a signal, between the limits set by diodes D3 and D4. The circuit will still work without it, but it was felt to be more elegant to include a tie-down resistor here. The inclusion of capacitor C16 acts as an r.f. bypass component.

Although the unit is intended for use as an input signal source for a normal HiFi set-up, with its a.f. outputs taken from a pair of parallel-connected phono sockets, it is quite capable of driving a pair of high impedance headphones without further amplification.

POWER SUPPLY

For simplicity and cheapness to operate, a mains derived single supply voltage rail was chosen and used in the prototype, see Fig. 3. However, the supply voltage is not particularly critical, and the circuit will work quite well from any supply line from +9V up to +24V. Since the Tuner only

consumes about 10mA it would be quite feasible to run it from a 9V layer cell dry battery, provided that one didn't want too big a signal voltage output.

An i.c. voltage regulator, IC2, is used to smooth the d.c. supply line and to keep the background "hum" level low. The author used a "7815" device, because these are easy to come by, and several were to hand.

However, if available, a 7824 regulator i.c. could be used as a direct replacement for IC2. In this case resistor R17, in Fig. 3, should be omitted and R18 replaced by a shorting link.

The mains transformer T1 is a 3VA type, with a 20V-0V-20V secondary, and is mounted directly on the p.c.b.

CONSTRUCTION

Although a metal housing would give a more up-market appearance, these tend to be rather expensive so a plastic Verobox was chosen for this unit, see photograph. Some screening is necessary, however, and this was provided by cutting a piece of stiff cardboard to fit the base of the box, and then sticking a layer of aluminium cooking foil to its underside.

The p.c.b. is then mounted above this on 4mm spacers, and the foil is earthed by way of a solder tag trapped between the foil and the box.

The printed circuit board topside component layout and full size underside copper foil master pattern for the Single-Station Radio 4 Tuner (LW AM) is shown in Fig. 4. It also includes details of wiring to the off-board components. This board is available from the *EPE PCB Service*, code 101.

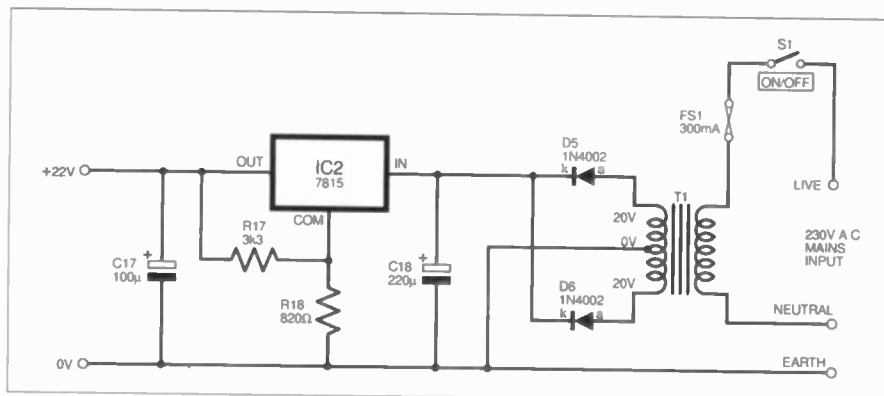


Fig. 3. Circuit diagram for the Tuner mains power supply.

Commence construction by first installing an 8-pin i.c. socket on the p.c.b. and then inserting the horizontal link wire, just below the i.c. holder, and the "grounding" link wire from the cathode (k) of D2, see Fig. 4. The solder pins can also be inserted at this stage.

COMPONENTS

Resistors

R1, R9	220k (2 off)
R2, R10	1k5 (2 off)
R3	4k7
R4, R5, R15	10k (3 off)
R6, R7, R8, R16	100k (4 off)
R11, R12	3k3 (2 off)
R13	5k6
R14	2k2
R17	3k3 0.5W
R18	820Ω

All 0.25W 5% carbon film, except R17

Potentiometer

VR1	100k min. rotary carbon, lin
-----	------------------------------

Capacitors

C1	15p polystyrene
C2, C4, C7, C15, C16	100n polyester (5 off)
C3	100p polystyrene
C5	18p polystyrene
C6	100n disc ceramic
C8	68p polystyrene
C9	22n ceramic bead
C10	4n7 polyester
C11	33n disc ceramic
C12	1µ polyester
C13, C14	2µ2 radial elect. 63V (2 off)
C17	100µ radial elect. 35V
C18	220µ radial elect. 35V
VC1, VC2	5p to 60p foil dielectric trimmer (2 off)

Semiconductors

D1 to D4	1N4148 signal diode (4 off)
D5, D6	1N4002 1A 100V rec. diode
TR1, TR4	2N3819 n-channel f.e.t. (2 off)
TR2, TR3	BC184 npn transistor (2 off)
IC1	TL072CN dual low-noise op.amp
IC2	µA7815 + 15V 1A voltage regulator (or 7824 24V 1A reg. - see text)

Miscellaneous

L1, L2	4.7mH inductor, Toko 10RB (2 off)
T1	Mains transformer, 3VA p.c.b. mounting type with 20V-0V-20V secondary
SK1	4mm socket, red
SK2, SK3	phono socket (2 off)
FS1	300mA fuse, with panel mounting fuseholder
S1	s.p.s.t. 230V a.c. 1A toggle switch

Printed circuit board available from *EPE PCB Service*, code 101; plastic case, size 180mm x 110mm x 49mm approx; 8-pin d.i.l. socket; single-ended solder pins; multistrand connecting wire; 3-core mains cable; strip of cardboard and aluminium foil for screening; stand-off insulators and fixing nuts and bolts, solder etc.

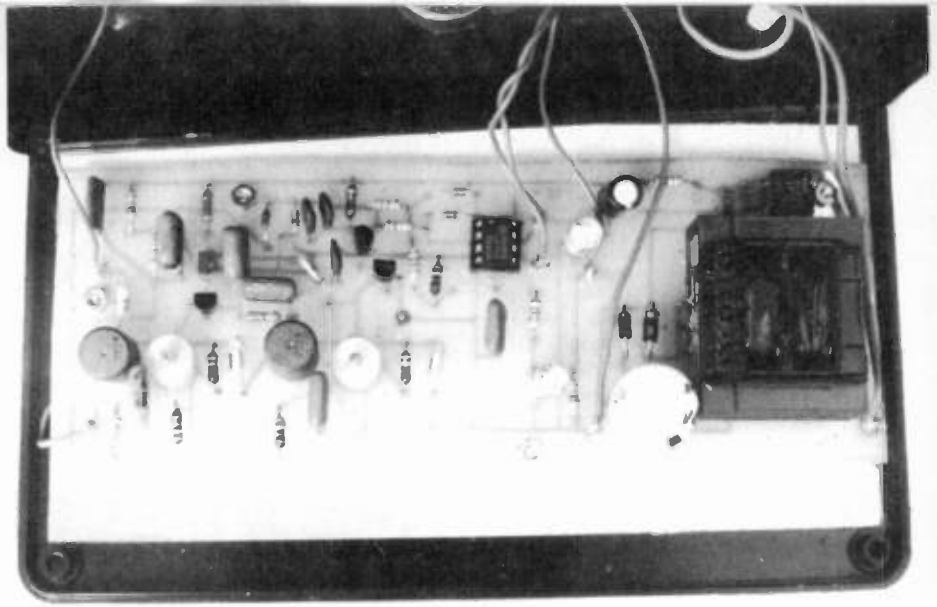
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This should be followed by the resistors and capacitors, in size order – starting with the smallest component. When inserting the electrolytic capacitors, check their polarities first before soldering in position.

Next, the diodes, transistors and voltage regulator IC2 should be inserted on the board. Once again, double-check their polarities before committing them to the solder treatment. When installing the voltage regulator, its pinout leads must be very carefully bent over so that the body of the device lays flat just above the surface of the p.c.b.

The small, circular shaped, trimmer capacitors and inductor coils can now be installed on the board. Be extra careful when soldering the inductors in position as they do not like too much heat. The hot soldering iron bit should be applied to their connecting tags for as little time as possible to perform a neat soldered joint.



Layout of components on the prototype printed circuit board.

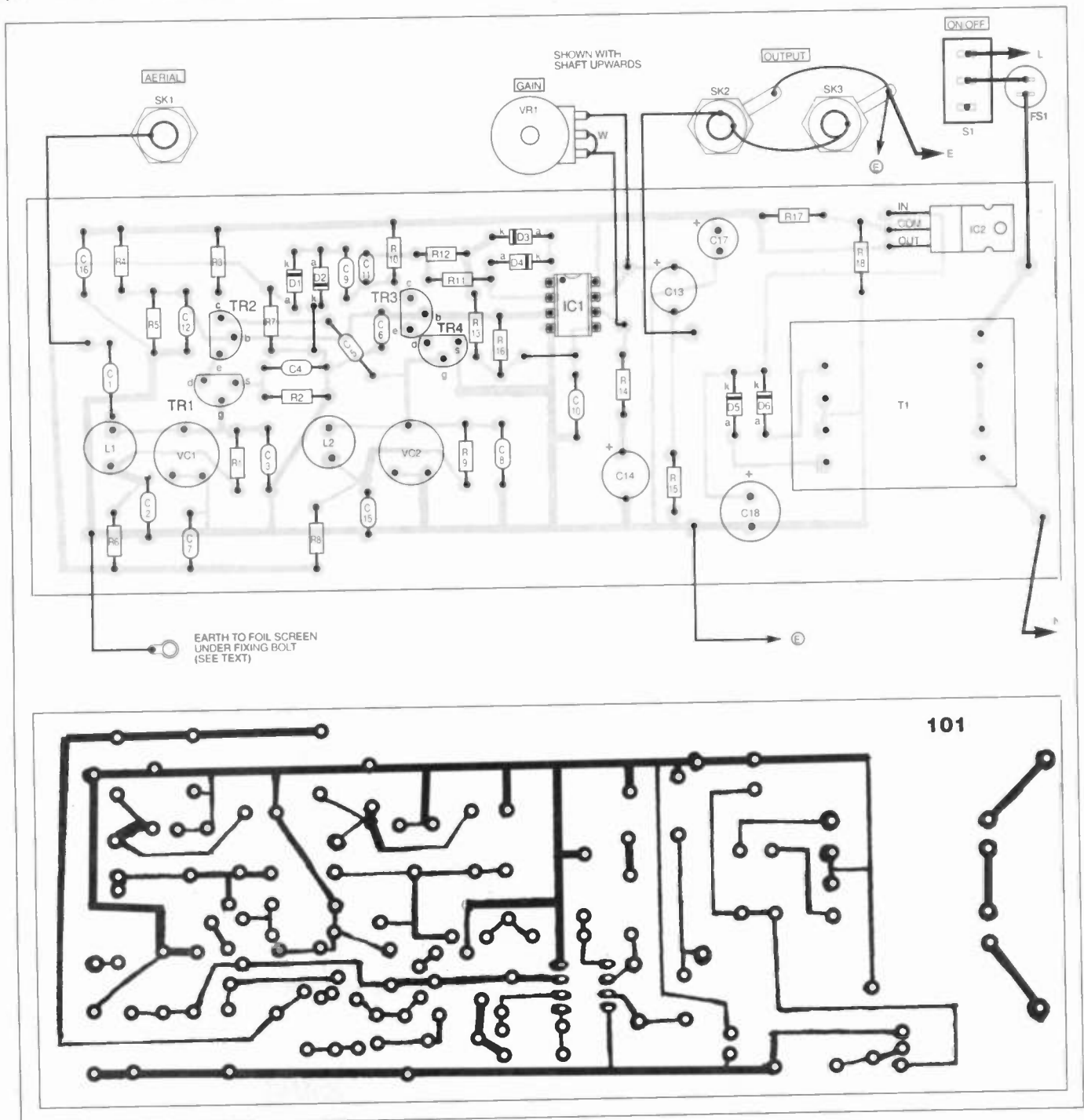


Fig. 4. Component layout, interwiring and full size foil master for the Single-Station Radio 4 Tuner.

Finally, the mains transformer can take its place on one end of the board and lengths of lead-off wires attached to the solder pins, leave enough "slack" so that the board can be removed, with the lid, from the case. Do not attach the mains cable at this stage.

FINAL ASSEMBLY

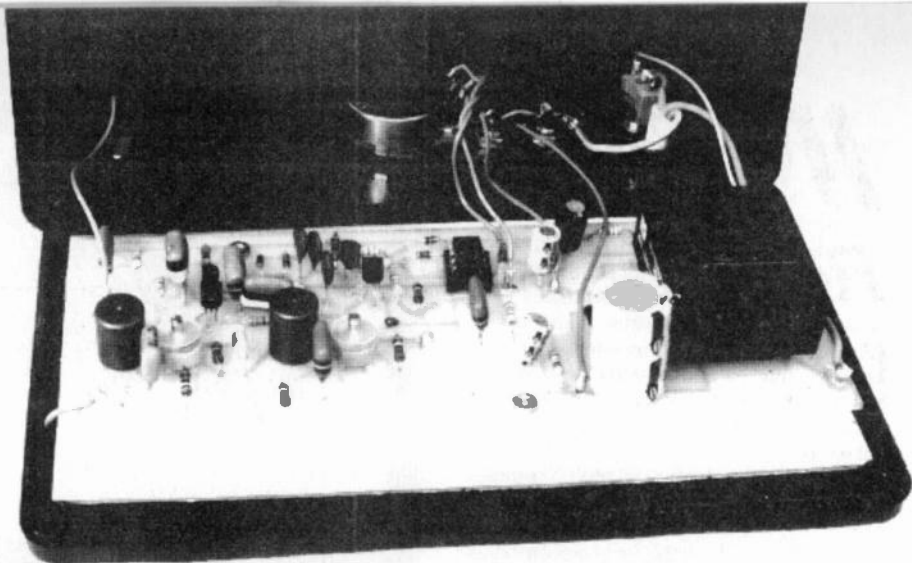
The next operation is to install the p.c.b., together with the cardboard and foil "screening card", on the lid of the case as described earlier. Do not forget to mount the screening solder tag under one of the mounting bolts so that it contacts the foil to form the required "earthing" screen connection.

Once the p.c.b. has been safely bolted onto the lid, all that remains is to locate the sockets, potentiometer, on/off switch and fuseholder on one side of the case and complete the interwiring as shown in Fig. 4. Leave space for drilling the entrance hole for the mains input cable.

When the multistrand connecting wires from the board have been soldered to their off-board components, the mains input hole can be fitted with a rubber grommet and the 3-core mains lead fed through and soldered in position as indicated in Fig. 4. It is good practice to fit a cable strain relief clamp to the cable, inside the case, or to use a clip type clamping grommet.

It is most important that the Live (L) and Neutral (N) pins on the p.c.b. be covered with insulating sleeving once the mains lead has been soldered to them.

On completion of the wiring up, the op.amp IC1 can be plugged into its socket ready for the setting up procedure.



The circuit board mounted on the case lid above the "screening card".

SETTING UP

To set up the Tuner, initially, first check that there is the right voltage on the positive supply line. Then set the Gain control VR1 to maximum value, and take a fairly long length of aerial wire – say three or four metres or so – and connect it to the top of coil L2. (The nearest point on the p.c.b. would be at the junction of R9/C8).

Adjust trimmer VC2 until Radio 4 is audible, and as loud as possible. Then do the same with the aerial connected to transistor TR2's collector.

Repeat the exercise, to tune coil L1, but this time with a somewhat shorter wire connected to the normal aerial input socket SK1, and with VR1 reduced to a lower level, as needed. The two trimmer capacitors (VC1 and VC2) will probably

be somewhere near their half-way position when correctly tuned.

A word of warning is needed, however, in respect of noise interference. In this age of FM receivers, a lot of domestic noise sources can be ignored. This isn't the case with AM, especially on the LW band, where quite a lot of gadgets cause noise – particularly fluorescent light systems, and especially the little "high-efficiency" lamp bulb replacements.

So, if you have a high man-made noise level, (one which disappears when the aerial is unplugged) this could be due to such a noise source, even in a room on the other side of a partition wall. In this case the only answer is to try a different site for the aerial – perhaps, as in car radios, at the end of a screened lead. □

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INTERFACE

Robert Penfold



IN LAST month's *Interface* it was mentioned that it is possible to obtain RS232C driver chips that only need a single 5V supply. On-chip switch mode power supply circuits generate the supply potentials of plus and minus 10V or 12V that are needed to provide proper RS232C drive voltages.

This method is clearly the most convenient way of handling things, but it can also be much more expensive. Some of the driver chips which have built-in power supply circuits cost around ten pounds each.

MAXimum Economy

The MAX232CPE is one of the cheaper types, and at a cost of about three pounds or so it represents an economic solution to the dual supply problem. It provides two RS232C drivers and two receivers. It can therefore be used to provide the transmission and reception lines, plus one handshake input and one handshake output.

If no handshaking is used, the MAX232CPE can be used to provide data inputs and outputs for two UARTs. A +10V supply output is available, and this can be used to hold any unused handshake inputs in the high (active) state.

The integral switch mode power supply requires no expensive inductors. In fact the only discrete components required are five capacitors.

A circuit diagram for a line driver and receiver based on the MAX232C is shown in Fig. 1. It provides dual 10V supplies using a simple switching system that is similar to that used on the ICL7660 negative supply generator,

which will probably be familiar to many readers.

This system is based on electronic changeover switches and capacitors. In this case it is not just a negative supply that is required, but voltage doubled positive and negative supplies.

Double Action

How a voltage doubling action can be provided is shown in Fig. 2. S1 is the electronic switch, and it is alternated between its two positions at a rate which is normally a few tens of kilohertz. A fairly high switching frequency is preferable as it enables relatively low value capacitors to be used.

With S1 in the position shown in Fig. 2, capacitor C1 is charged across the input supply. It is then discharged into capacitor C2 when S1 is switched to the opposite position.

Therefore, the basic action of the circuit is to transfer power from the input supply to C2 via C1. This generates a positive voltage across C2, and the voltage here is equal to the potential of the input supply. However, the potential across C2 is in series with the input supply, and is added to it to give a voltage doubled output.

A little rearrangement of the circuit is all that is needed in order to generate a negative output potential equal to the positive supply voltage. It is just a matter of reversing the polarity of the input supply and the two capacitors.

Generating a negative supply that is double the positive input voltage is a little more difficult, as there is no negative supply to which the new supply voltage can be added. How-

ever, it is possible to generate two negative supplies which are then added together to give a voltage doubled supply.

Although in theory it is quite simple to generate voltage doubled supplies using this switching method, in practice it is quite difficult. The electronic switches must operate at potentials well outside the limits of the input voltage, and they must have low "on" resistances or the output voltage will "sag" significantly under loading.

These problems seem to have been solved in the MAX232CPE, which provides loaded supply potentials of about plus and minus 9V.

Golden Handshake

Returning to the circuit of Fig. 1, capacitor C1 provides supply decoupling, while C4 and C5 act as the reservoir capacitors on the positive and negative supplies respectively. Capacitors C2 and C3 provide the transfers from the input rails to the output supplies.

The -10V supply is available at pin 6, but external access to this supply is not normally needed. The +10V supply can be accessed at pin 2, and this supply can be useful as a tie point for unused handshake inputs on the computer's serial port.

On the face of it, the handshake lines can be ignored unless you are actually utilizing hardware handshaking. In reality, many computers will refuse to output any data unless the relevant handshake input is taken high. Some computers generate a time-out error message when used to receive data from

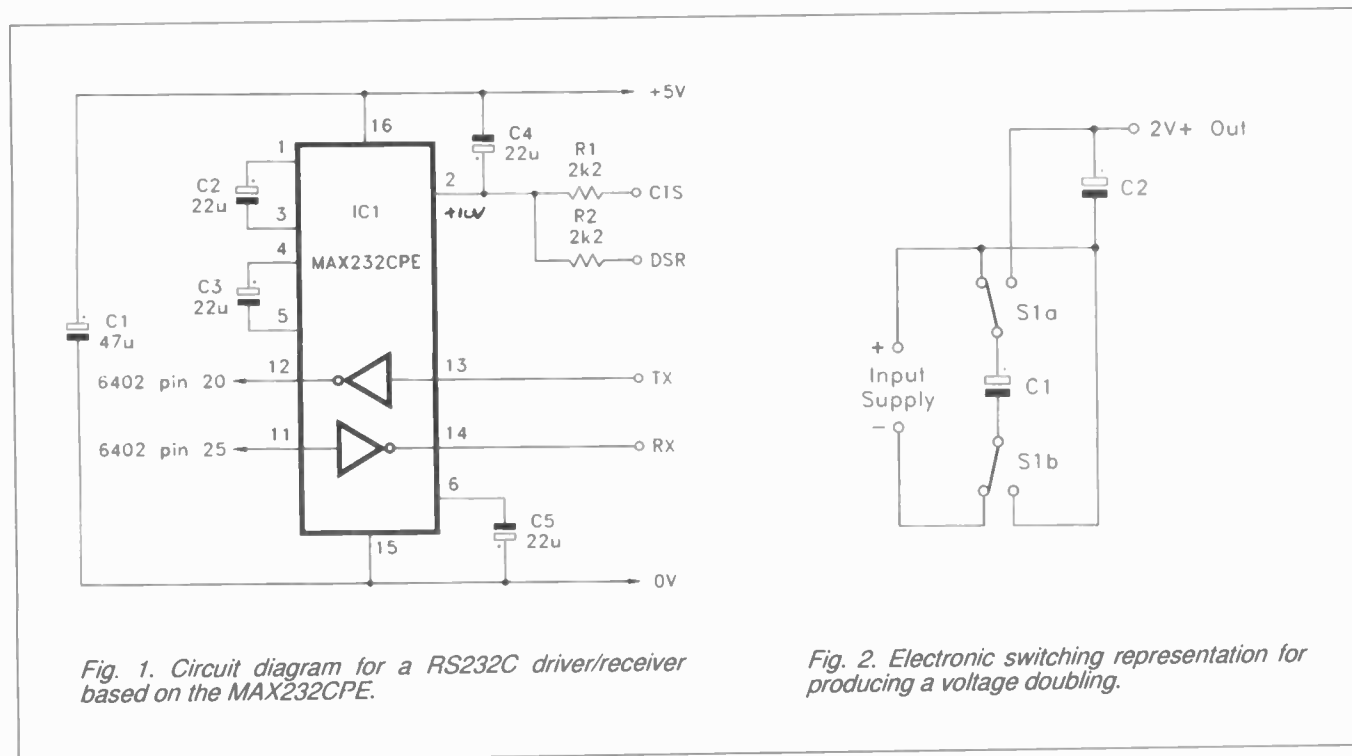


Fig. 2. Electronic switching representation for producing a voltage doubling.

Exactly which handshake lines have to be taken high depends on the computer in use, and it is often necessary to indulge in a little trial and error in order to get everything running correctly. In fact serial interfaces are notoriously unpredictable, and it is quite normal if a certain amount of experimentation is needed before everything works as expected.

The serial output signal from the 6402 UART is fed to pin 11 of IC1, and the inverted output signal at RS232C levels is produced at pin 14. The dual 10V supplies are slightly low for an RS232C driver, but the loaded output voltages are still more than adequate for reliable results. A second driver is available, and its input and output are at pin 10 and pin 7 respectively.

Right Connection

In order to keep the radiation of radio frequency interference (r.f.i.) to a minimum, the connecting cable should be a good quality screened type. The ground (GND) interconnections are carried by the outer braiding of the cable, and the other connections are carried by the inner conductors.

Making Contact

From the software point of view, using a serial interface tends to be rather more awkward than using the parallel variety.

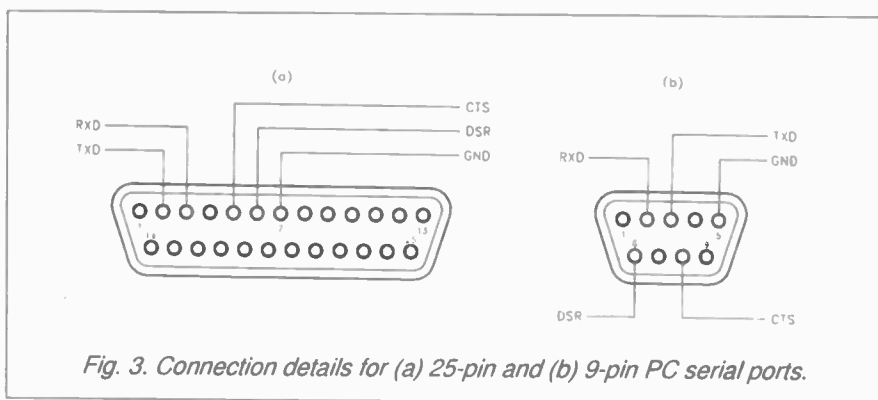


Fig. 3. Connection details for (a) 25-pin and (b) 9-pin PC serial ports.

With PCs the serial port can be set up from MS/DOS using the MODE command. The baud rate and word format must be the same for both transmission and reception. The MODE command takes five parameters which select the serial port, set the baud rate, the type of parity (if any), the number of data bits, and the number of stop bits.

The word format of the serial encoder/decoder is no parity, eight data bits, and one stop bit. When using the crystal controlled baud rate generator with a baud rate of 9600, the MODE command for serial port 2 (COM2) is:

If the simple 1200 baud C-R baud rate generator is used, the appropriate MODE command for serial port 1 (COM1) is:

For software running under WINDOWS the "PORTS:" icon in the "CONTROL PANEL" is double-clicked, and then the required communications port is selected. You then select the required baud rate and word format in standard WINDOWS fashion.

The "Flow Control" options enables the required type of handshaking to be selected, which will normally be "None" for your serial port add-ons. Under WINDOWS 95 the route to the right menu is "My Computer", "Control Panel", "System", "Device Manager", and "PORTS".

Virtually any programming language should provide support for the serial ports, and it may be possible to set the

```
OPEN "COM2:9600,N,8,1" AS #2
```

There is often a problem in using the serial port support in that it seems to be mainly geared towards the transfer of files, rather than single bytes of data. A byte of data to the port is likely to be sent together with control codes, and these codes may also be expected by the program when the port is read.

In some cases it may be easier if the serial port is controlled directly, rather than via the routines provided by the programming language. This certainly seems to be the case as far as write operations are concerned.

The serial port data latches are at addresses &H3F8 (port 1) and &H2F8 (port 2). Data written to one of these addresses will be transmitted from the appropriate serial port.

Thus, using GWBASIC it is possible to write bytes of data to the serial ports using the OUT instruction. This example writes a value of 85 to serial port 2:

OUT & H2F8,85

No So Fast

The only point to bear in mind when using this method is that data must not be written to the port at a higher rate than it can be transmitted. The easiest way of doing this is, where necessary, to use a simple timing loop to provide a delay so that the flow of data is restricted to a rate that the port can readily handle. This will probably require a little trial and error, and it is just a matter of using the shortest delay that gives reliable results with no "lost" bytes.



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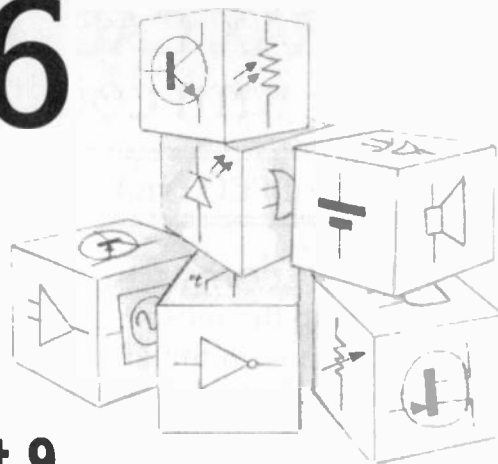
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TEACH-IN '96

A Guide to Modular Circuit Design

Max Horsey

Part 9



DURING this series of articles, a range of circuit modules is examined, divided into Input, Processor and Output sections. Where possible a choice of module is offered within each section.

Each of the ten Parts of the Series is accompanied by a constructional article explaining how a complete project may be devised by employing the modules described, together with a p.c.b. design. Each project will be one of many possible ideas that could be

implemented and it is hoped that readers will design for themselves a variety of circuits by combining modules provided in the whole series.

The proposed range of modules covered by the Series is detailed in Part 1, Table 1.1. Each module is chosen to link easily with adjacent modules in the same Part, but modules may also be linked with modules in other Parts of the Series.

Max Horsey is Head of Electronics at Radley College.

THIS part is concerned with looking at circuits which generate short bursts of data. Such techniques can be very cost effective in terms of power consumption and the amount of data which can be transferred. Computer networks and digital mobile phones, for example, make use of this idea.

The following modules are discussed in this part:

INPUT MODULES: Astables with unequal mark/space ratios

PROCESSOR MODULES: Missing pulse detectors

OUTPUT MODULES: Relays and reed switches

MARK THAT SPACE

When designing a circuit which generates short bursts of data, it is necessary to start with a pulse waveform which has a very short "mark" or "on" time compared with a longer "space" or "off" time. The data transferred can be a single on/off pulse, or it can be a stream of coded pulses whose length and spacing varies according to the code transmitted.

It is also possible to design circuits which can be used as "missing pulse detectors". These circuits can be used to monitor a wide variety of signal sources, such as heart beat detectors, for example. If the time between two consecutive heart beats is longer than permitted by the circuit, an alarm sounds.

As shown in the accompanying project, a missing pulse detector can also be used to monitor two coded infra-red (IR) beams. If both beams are broken at the same time an alarm sounds.

PULSE GENERATORS

Some designs may require a short burst of power, followed by a long pause. For example, an infra-red beam system is much more power efficient if the beam is emitted in very short bursts. This prolongs battery life and enables the use of a much more powerful IR beam without causing damage to the transmitter.

A simple series capacitor will convert a series of square waves into a series of pulses having uneven mark-space ratios, i.e. the pulse is "on" for a shorter period

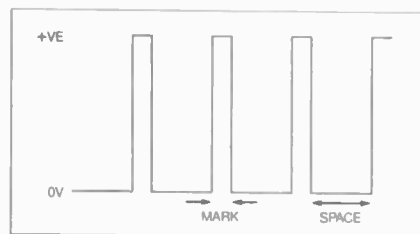


Fig. 9.1. Unequal mark/space ratio pulses.

than it is "off". The principle was described in Part 2, under "A.C. Coupling".

However, some of the astable modules described in Part 4 can also be readily adapted to produce unequal mark/space ratios, as illustrated in Fig. 9.1

A further three choices of astable which generate unequal mark/space ratio pulses are described below:

555 ASTABLE

A type 555 timer i.c. (integrated circuit) when configured in astable mode is particularly good at generating pulses having an unequal mark/space ratio.

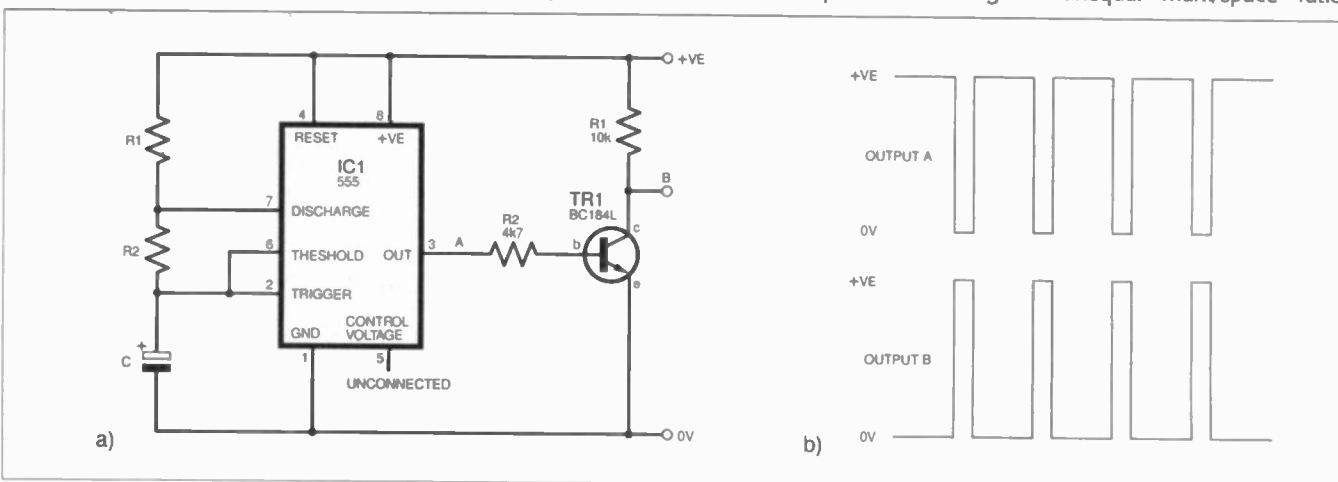


Fig. 9.2(a). A 555 timer i.c. configured for unequal mark/space ratio output pulses, with inversion by TR1. The waveforms are shown in (b).

Referring to Fig. 9.2(a), if the output of IC1 is taken directly from pin 3 the "mark" (high) will be longer than the "space" (low). If this is the opposite of what is required, it may be inverted by means of a NOT gate (inverter), or a transistor (TR1) as shown.

As discussed more fully in Part 4 (Fig. 4.11), the "mark" (T1) time at the 555's output pin 3 is calculated as:

$$T1 = 0.7 (R1 + R2) \times C$$

The "space" (T2) is calculated as:

$$T2 = 0.7 \times R2 \times C$$

The inverted output at the collector of TR1 is more suitable for driving circuits where short bursts of power are required (within the current restrictions imposed by the value of resistor R2).

Although the 555 is often ideal for this type of application, the warning previously mentioned in Part 4 still applies, namely the difficulty sometimes experienced when mixing the standard 555 with CMOS logic i.c.s in the same circuit.

Beware, too, that the standard 555 consumes more power than its CMOS counterpart.

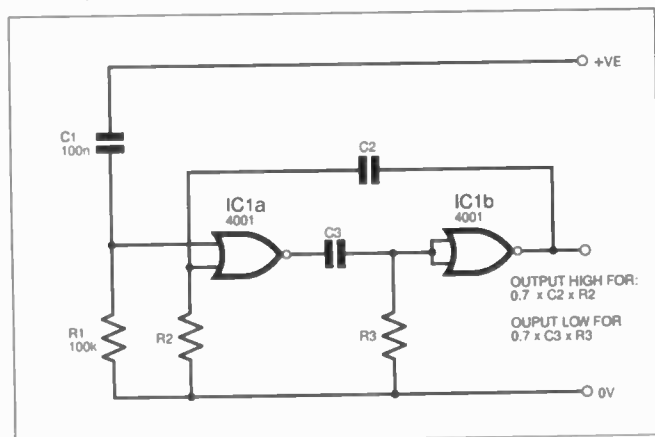


Fig. 9.3. Circuit diagram for a NOR gate astable.

NOR GATE ASTABLE

Independent control of the "mark" and "space" may be achieved by means of the NOR gate astable circuit shown in Fig. 9.3. This is a development of the modules discussed in Part 4, and includes the "kick-start" components, resistor R1 and capacitor C1. These ensure that the astable starts oscillating at power up.

The "mark" time is set by capacitor C2 and resistor R2, and the "space" time by C3 and R3.

The output from IC1b is high (positive) for a time given by:

$$T1 = 0.7 \times R2 \times C2$$

As usual, it is more convenient to measure the resistance in megohms (M Ω) and the capacitance in microfarads (μ F). The time, T1, will then be in seconds.

The output from IC1a will be high (positive) for a time given by:

$$T2 = 0.7 \times R3 \times C3$$

Remember that when the output from IC1a is high, the output from IC1b will be 0V (low) and vice versa. The signal may be taken from the output of either gate.

The design is more flexible than with the 555 device since the "mark" and "space" are under independent control. However, the frequency of the circuit is more prone to drifting due to temperature and supply voltage fluctuations.

NAND GATE ASTABLE

An astable can be made with NAND gates just as easily as with NOR gates, as shown in Fig. 9.4. Note, however, that the output states are the reverse of those for the NOR gate in Fig. 9.3.

The other main difference to the NOR gate circuit is the automatic kick-start arrangement. The components R1 and C1 are the opposite way round, so that the upper input (as seen in Fig. 9.4) to IC1a is held high due to the effect of R1.

At the moment of switch on, this input will start at 0V, but as capacitor C1 charges, the input will become sufficiently positive for the gate to "kick-start" the circuit into action.

CONTROLLING A MODULE

The purpose of the astables discussed so far is to provide an unequal mark/space ratio to control the action of another circuit. For example, the Infra-Red Transmitter featured in Part 5, and used again in the project associated with this Part 9, forms part of an alarm circuit and must therefore be kept running continuously.

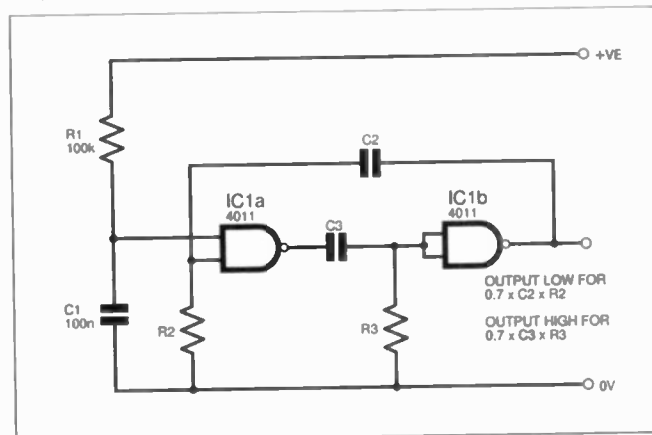


Fig. 9.4. Circuit diagram for a NAND gate astable.

However, it is much more power-efficient to transmit short bursts of coded infra-red, rather than one continuous stream. The modules shown in Fig. 9.5 allow such a circuit to be controlled.

In Fig. 9.5a, the stream of data is fed to one input of the AND gate IC1. The output of the astable is fed to the other input. The AND gate only allows the data pulses to pass through to the output when the astable pulse is high. Normally, the astable "mark" period would be set shorter than the "space" period. Obviously, though, the "mark" period must be correctly chosen to allow the required number of data pulses to pass through the gate.

When the output from the astable in Fig. 9.5a is low (i.e. about 0V), the output from the AND gate will also be low. When the astable output switches high

and the diode may be any small signal type, such as a 1N4148.

Providing the resistor allows enough current for the next stage of the design, then this simple method works very well.

MISSING PULSE MODULES

A classic use of the missing pulse detector is in a heart-beat monitor. If the time between two consecutive heart beats is longer than permitted by the circuit, an alarm sounds. There are many other applications, and such a module is particularly helpful in monitoring all sorts of functions but, in order to save power, to only send an "all OK" message at intervals.

For example, you may wish to send a (legally approved) radio signal from your greenhouse to your home to ensure that the correct temperature is maintained. For a battery powered transmitter, it would be expensive to leave it running continuously.

However, if the system is designed to transmit only when the temperature is wrong, there is no easy way of ensuring that the transmitter has not developed a fault when no signal is being received. But if the transmitter is designed to transmit a short pulse every 10 seconds, for example, when the temperature is correct, very little power

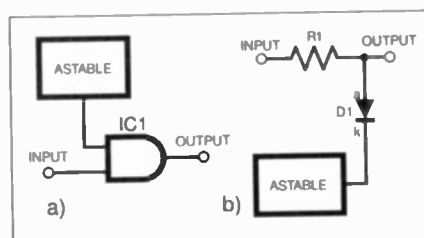


Fig. 9.5. Two methods for pulsing data.

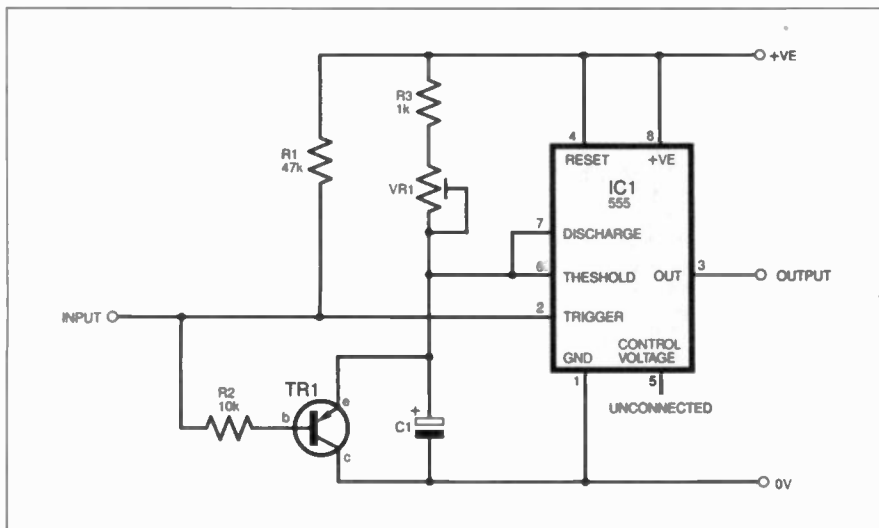


Fig. 9.6. Circuit diagram for a 555-based pulse monitor.

will be consumed, and the system will be fail-safe. The receiving circuit will monitor the pulses, and sound the alarm if they stop.

Three missing pulse processing modules are featured here. The first (Fig. 9.6) is based on the type 555 timer i.c., the second is based on CMOS NOR gates (Fig. 9.7) and the third on CMOS NAND gates (Fig. 9.8).

555-BASED PULSE MONITOR

In Fig. 9.6 is shown the circuit diagram for a missing pulse detector based around a 555 timer, IC1. It is basically a monostable as shown in *Teach-In* Part 2 (Fig. 2.10). However, the addition of the pnp transistor TR1 allows incoming pulses to continually discharge the timing capacitor C1 before it can charge up sufficiently to complete its timing cycle.

Note that resistor R1 holds IC1 pin 2 and the base (b) of the transistor high. Since the transistor is a pnp type (such as BC214L or similar), it will normally be switched off. If the input is made low, IC1 will be triggered, its output switching high.

If no more negative pulses are received, the output will revert low after a period given by the formula:

$$T = 1.1 \times R \times C$$

Remember that R must be in Ohms, and C in Farads for the time T to be in seconds. A useful short-cut is to measure the resistance in MΩ (megohms) and the capacitance in μF (microfarads). Mathematically, the mega (M) will cancel with the micro (μ) and so the answer will still be in seconds.

For example, if the combined resistance of the variable resistor VR1 and the fixed resistor R3 is 1MΩ then the period (in seconds) will be roughly equal to the value of the capacitor in μF.

Returning to the circuit, if further negative pulses are received before the time T has elapsed, then transistor TR1 will switch on, causing capacitor C1 to discharge and preventing the monostable from completing its normal period.

To sum up the missing Pulse Detector circuit in Fig. 9.6:

- If Input is high then Output is low
- If Input is made low then Output switches high
- If Input is continually switched high/low then Output remains high
- If Input remains high then Output switches low

In other words, a continuous stream of incoming pulses will keep the timer's output positive. If the pulses cease, the output will switch back to 0V.

A preset potentiometer would normally be used for the variable resistor VR1, unless frequent changes of value are envisaged. Having established how many pulses per second are to be monitored, the timing period set should be longer than the interval between pulses. In many applications, the actual period will not be critical and VR1 can be omitted, in which case resistor R3 should be increased to the value required and connected directly to the junction of TR1 and C1.

NOR-GATE PULSE MONITOR

The missing pulse detector in Fig. 9.7 is based on NOR gates. The pin numbers shown relate to the CMOS 4001B quad NOR gate i.c. The individual gates may be used in any order and alternative NOR gates may be used, such as the 74HC02, though be aware that a different pin out arrangement applies (see Part 1, Fig. 1.14 for pin details).

Three NOR gates are required for this circuit. Note that two of the gates are just used as NOT gates (inverters), their inputs being joined. In a practical circuit, it may be more convenient to use single NOT gates, or even NAND gates converted to NOTs by joining their inputs. The choice depends upon the other requirements of the circuit and the spare gates which may be available; expediency often dictates what form a circuit and its components choice may take.

The module is based on the CMOS monostable described in Part 2 (Fig. 2.8). When the circuit is in its standby state, its input will be low and so the output will also be low. When the input is made high the output will switch high and remain so for a period according to the formula:

$$T = 0.7 \times R \times C$$

where

- T = timing period,
- R = total resistance of R2 plus VR1
- C = value of C1.

As before, a convenient shortcut is to assume a value of 1MΩ for R, in which case the timing period in seconds will be about two-thirds of the value of C if measured in μF.

Assuming that the input is allowed to return low, the extra gate IC1c will have

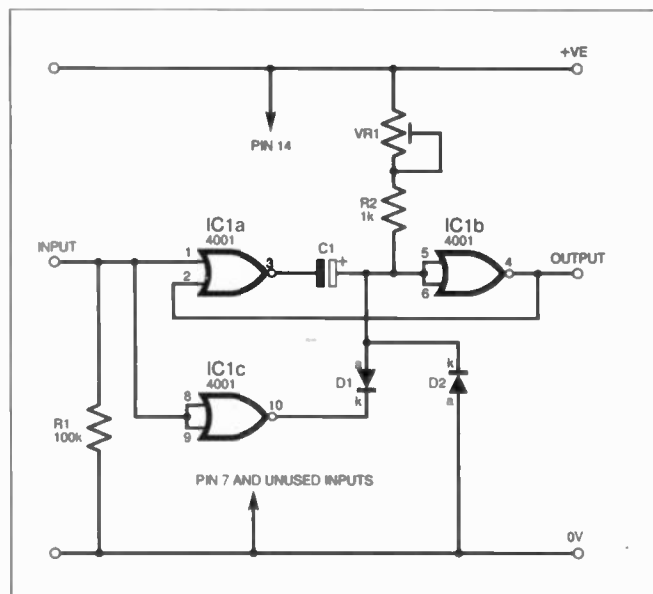


Fig. 9.7. Circuit for a NOR-gate pulse monitor.

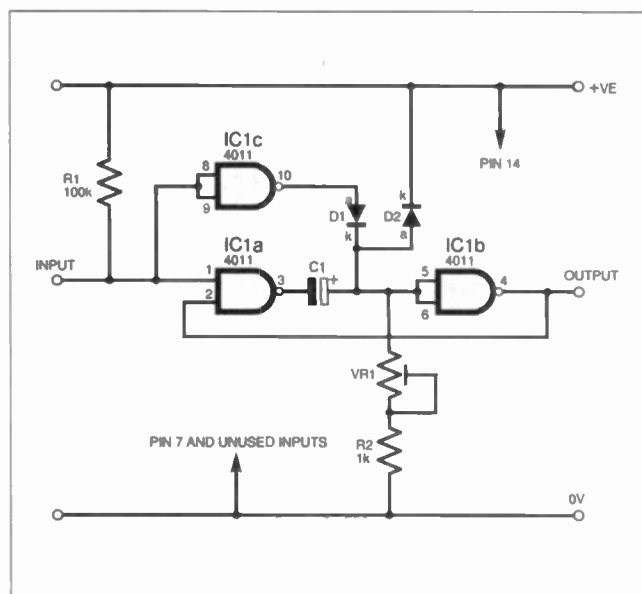


Fig. 9.8. Circuit for a NAND-gate pulse monitor.

no effect since diode D1 will prevent current flowing from IC1c pin 10 towards capacitor C1. But if another positive pulse is received at the input, then IC1c pin 10 will switch low and cause the slowly rising voltage at IC1b pins 5 and 6 to collapse. The output from IC1b pin 4 will therefore stay high.

To sum up the missing pulse detector circuit in Fig. 9.7:

- If Input is low then Output is low
- If Input is switched high then Output switches high
- If Input continually switches low/high then Output remains high
- If Input remains low then Output switches low after timing period

In other words, a continuous set of pulses at the input will cause the output to remain positive, but if the pulse stream stops, the output will switch to 0V.

Diode D2 is provided to ensure that the voltage at IC1b pins 5 and 6 is never allowed to go negative. This could happen if pins 5 and 6 are held at 0V by IC1c pin 10, and then IC1a pin 3 switches to 0V. With diode D2 fitted, the voltage cannot fall below 0V (ignoring the usual forward voltage drop across it). Internal diodes in the gate should prevent damage, but D2 is a useful safety addition. Both D1 and D2 can be any type of silicon diode, such as type 1N4148.

A preset potentiometer would normally be used for VR1 unless frequent changes of value are envisaged, in which case a panel mounted potentiometer would be used. Having established how many pulses per second are monitored, the timing period should be set for longer than the interval between pulses.

The actual period will rarely be critical and VR1 can be omitted in many applications, in which case resistor R2 should be increased to the value required and connected directly to positive rail.

NAND-GATE PULSE MONITOR

A monostable can be made by means of NAND gates as shown in Fig. 9.8. Note that only one NAND gate is really required (IC1a) since two of the gates (IC1b and IC1c) are wired as NOT gates by joining their inputs together. Single NOT gates may be used, or NOR gates wired as NOTs. As before, it depends upon other requirements of the circuit.

Like the 555 module in Fig. 9.6, the circuit requires negative-going (0V in this case) pulses at its input. Each 0V pulse causes IC1a output pin 3 to switch high. IC1b pins 5 and 6 also switch to high, making IC1b pin 4 switch low. The positive voltage at IC1b pins 5 and 6 will fall as current flows through the resistor R2 and preset VR1 to the 0V rail. After the timing period has elapsed, the output at IC1b pin 4 will switch back to positive. The timing period is calculated in the same way as for the circuit in Fig. 9.7:

$$T = 0.7 \times R \times C$$

The additional gate, IC1c, ensures that if further 0V pulses are received before the end of the timing period, IC1b pins 5 and 6 will be held positive via diode D1, keeping the output (IC1b pin 4) at 0V. Only if the negative-going pulses at the input cease for longer than the timing period will the output return to positive.

Diode D2 ensures that IC1b pins 5 and 6 are never at a higher voltage than the

supply rail. This could otherwise occur in a similar (but opposite) way to that prevented by diode D2 in Fig. 9.7. Both D1 and D2 can be any silicon diode type, such as 1N4148.

The points made in the NOR gate version of Fig. 9.7 about preset VR1 and the choice of gates apply equally here. For example, the i.c. suggested for IC1 is the CMOS NAND gate 4011B, but a 74HC00 i.c. may be substituted, noting that the pin numbers are different (Part 1, Fig. 1.14 for the pinout details).

To sum up the missing pulse detector circuit in Fig. 9.8:

- If Input is high then Output is high
- If Input is switched low then Output switches low
- If Input continually switches high/low then Output remains low
- If Input remains high then Output switches high after timing period

In other words, a continuous set of pulses at the input will cause the output to remain low, but if the pulse stream stops, the output will switch to positive.

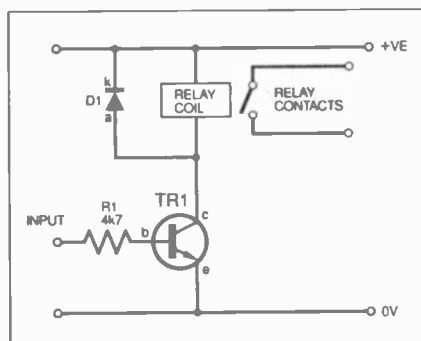


Fig. 9.9. Transistor controlled relay.

RELAYS REVISITED

A circuit which used a relay as the output device was first shown in Part 1 of the series and is shown again in Fig. 9.9. It is repeated here since there are a few additional points worth making about relays.

It is common to drive the relay coil from the collector of the transistor TR1. Whenever the voltage at the input in Fig. 9.9 moves above about 0.7V, the transistor turns on and energises the relay coil. This creates a magnetic field inside the coil, which in turn causes the movement of an armature. The armature in turn causes a switch to operate.

The actual working of a relay is not important as far as its application is concerned, but the description above indicates that, unlike the majority of electronic components, the relay is electromechanical. It therefore wears out after a certain number (admittedly very large) of operations and cannot switch on and off very quickly.

It would be unwise, for example, to flash a set of disco lights by means of a relay. The repeated switching and arcing across the relay contacts would shorten the relay life dramatically.

Relays are, however, very useful devices. Provided that repeated fast switching is not required, they offer a very useful method of control and isolation, particularly when the voltage being controlled is different from that used by the rest of the circuit.

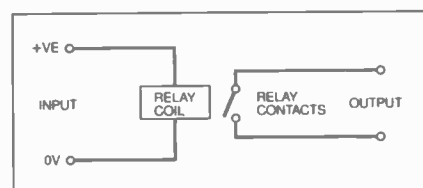


Fig. 9.10. Directly powered relay.

The circuit in Fig. 9.9 shows a transistor and relay employed as a single module. A relay can of course be used as a module without other components, as shown in Fig. 9.10, simply turning the coil voltage on and off, by a switch, for example. Notice that the input circuit in Fig. 9.10 is concerned entirely with the relay coil, and the output circuit involves only the switch contacts.

Modern relays can be very small, and very reliable. The range available has never been greater and care must be taken to select the best relay for the job. When selecting a relay, data for the coil and data for the contacts are entirely separate considerations.

COIL DATA

1. Voltage:

The coil voltage must correspond with the voltage available from the driving circuit. Typical coil voltages are 3V, 5V, 6V, 12V, 24V. Relay coils are generally designed for d.c. supplies, although 230V/250V a.c. mains coils are also available. Most relays will operate over a range of voltages across their coils. For example, a 6V relay may also operate on 5V. A good catalogue will always provide exact information.

2. Resistance:

The resistance of the relay coil determines how much current it will use. In general, the higher the resistance the better. However, low voltage coils need to have a fairly low resistance in order to provide enough force to operate the contacts. Relays with several sets of contacts will be fitted with a lower resistance coil than their equivalents having fewer contacts.

CONTACTS

1. Type of contacts:

The simplest contacts behave as a single-pole single-throw (s.p.s.t.) switch. When the relay coil is energised, the contacts close (switch on). Many relays have change-over contacts (single-pole double-throw – s.p.d.t.) which behave as a two-way switch. Most relays are offered with multiple sets of contacts as an alternative. They are a little more expensive, and their coils generally require a bit more current.

2. Contact voltage:

The voltage rating of the contacts is the maximum voltage which can be switched. Many relay contacts are rated at 120V a.c. – designed principally for the USA and other countries with similar mains voltages. *Be warned that these 120V a.c. relays must not be operated from the 230V/250V UK mains supply.*

If you wish to switch d.c. supplies, note that the maximum d.c. voltage allowable is often much less than the equivalent a.c. voltage. This is partly because d.c. causes much more arcing as the contacts separate, and partly because the peak a.c. voltage is greater

than the r.m.s. value. A good catalogue will clearly state the maximum a.c. and d.c. voltages permitted.

3. Contact current:

The maximum current which can be switched via the contacts of most common-place relays may be as little as under 1A or over 10A. Always be generous and obtain a relay with a greater current switching capacity than required.

OTHER FACTORS

The physical size and shape of a relay may be important in some applications. Some relays are designed for direct mounting on a printed circuit board. Others are designed for special sockets which must be purchased separately. Many have a set of solder tags.

Most relays are housed in a plastic case, and some are fully sealed to prevent contamination of the contacts.

REED RELAYS

The reed switch relay is a type of relay in which the armature and contacts are replaced by a reed switch which sits inside the relay coil. Reed relays are often smaller than other types, and their coils generally have a higher resistance resulting in lower current consumption. They are often designed for direct p.c.b. mounting.

The reed contacts generally have a lower voltage and current rating compared with standard types of relay, so limiting their usefulness. However, they are often used in alarm systems. For example, virtually all PIR (passive

infra-red) detectors contain a reed relay which links the PIR unit with the main alarm panel.

EXAMPLE PROJECT

The Twin-Beam Infra-red Alarm is the example project (elsewhere in these pages) which shows how the modules of *Teach-In Part 9* can be combined in a practical application.

PART TEN

This Teach-In series is concluded in Part 10. The subjects examined are magnetic pick-up sensors, frequency-to-voltage conversion and a linear VU display. The example project illustrates how a motor/shaft speed display can be constructed – ideal for cyclists!

Ohm Sweet Ohm

Max Fidling

War Paint

Springtime, and a quick tour under duress around a DIY superstore: nothing strikes terror into my heart more than the sight of the Boss holding one of those emulsion paint colour charts, because I know what's coming next . . . "The latest season's colours . . . time for a spring-clean . . . let's start next weekend!" she chides. Trouble lurked.

I left the Boss pondering the wonders of wall paint while I ambled casually over to the Hand Tools section, a glittering treasure trove of technical-looking twiddly bits with which I could impress my friends! Spying some likely plunder dangling from a hook, I sneaked a set of multi-gauge wire-cutters (with coloured cushion-grip handles to match the other bits 'n' bobs in my toolkit) into the wobbly-wheeled shopping trolley while the Boss still pondered the latest colour scheme.

Back at the ranch, I'd left the Boss pondering her tastes in paint, as she sloshed the first in a series of those little tester pots in a conspicuous area near the kitchen sink. Sensing trouble, I mooched over to the shack carrying my latest booty, to see how the wire strippers would look in their new home, followed by the cat, who looked distinctly hungry. I tipped some salmon and rabbit grub into Piddles' bowl and he started to munch with gusto, clattering his bowl as usual.

Colour Scheme

My mind started to wander as I contemplated gloomily a weekend of decorating. One problem I have is with the silly names the paint companies give all these colours. I have a theory that they employ someone specially to dream up these non-descript titles, which bear no relation to what the stuff actually looks like!

It's all designed to confuse, I explained to the cat. If I had my way, I rambled, I'd re-christen the lot at a stroke, probably

saving Britain's paint industry a fortune to boot! Forsythia would become Multi-meter Yellow! Buckingham could become Earth Terminal Green! Paxolin Brown . . . Burnt Out Black! Solder Grey! Now that's much better!

A sequence of names breezed across my brain while I tested the new wire cutters on some stout old offcuts of solid core wire. Bits of wire and insulation pinged off and ricocheted around the shack before rattling back to earth, burying themselves amongst the various piles of washing machine spares and other prized belongings. Piddles still scoffed on, regardless.

My fears materialised when it was announced finally that the kitchen was going to be painted Terracotta. By now the kitchen bore the hallmarks (or is it wallmarks?) of experimentation with several little tester pots. It looked positively awful! However, having just polished off my current electronic project in the shack, it was back to the superstore to purchase bulk supplies of the said Terracotta. (Brown, to me.)

Later that day, work duly began as I prised open a plastic paint container and peered miserably into the pot. It occurred to me that the paint could do with a jolly good stir before sloshing it around the kitchen, but my custom-made paint stirrer (an old screwdriver) was nowhere to be found. Not wishing to make work for myself, a plot hatched . . .

Wolf Man

This'll perk it up a bit, I reckoned, as I grabbed my trusty old "Wolf" electric drill. In a flash I had my drill stand bolted to the bench using two large G-clamps, which I screwed up tightly in a twirl. Eager to press on, the power drill slotted into place neatly on the stand, and bingo! Well, nearly – what to do for the "business end?" Perched on the shelf was my set of hexagonal Allen keys . . .

A 6mm Allen key was fitted tightly into the chuck, so that the short right-angle bit would act like a stirrer at the



end of the key's shaft. The paint pot was positioned under the drill, which by now looked like a weapon of torture, and I lowered the contraption confidently into the paint and switched on. Slowly the drill gathered speed as a satisfying whirlpool of Terracotta formed. The "Wolf" whisked the paint up into a Cappuccino-like frenzy for another minute or so, still neatly contained in the pot.

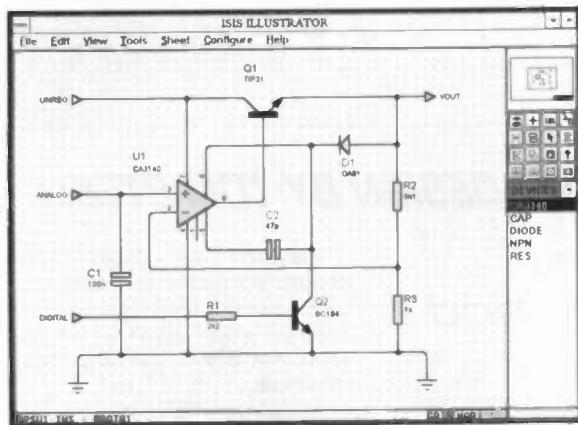
Terror-catta

As it accelerated still further, with a sudden "gloop" the emulsion gushed out of the tin in a muddy-looking fountain of paint which showered all over the bench! The drill, relieved of its load, cranked up into a crescendo of a scream as I struggled to turn the gizmo off!

Large globules of paint were flung off as I peppered myself and the moggie with tastefully arranged blobs of Terracotta! I wonder if Magnolia would do instead, I pondered, switching off the banshee electric drill and wiping my spectacles. I've lots of that. (Though I called it cream.)

CADPAK for Windows

CADPAK is especially suited to educational, hobby and small scale schematic and PCB design. CADPAK includes both schematic drawing and 32-bit PCB drafting tools but as an entry level product, there is no netlist link between them.



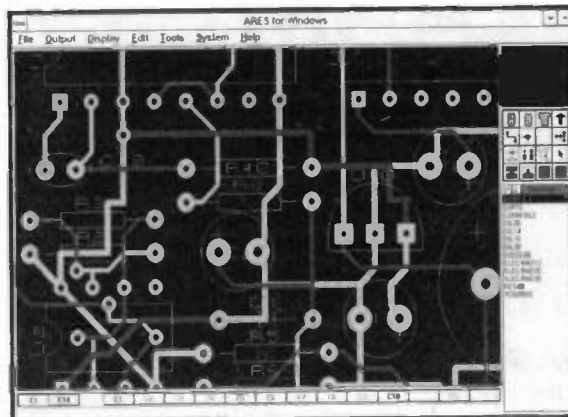
The schematic drawing module of CADPAK, ISIS ILLUSTRATOR, enables you to create circuit diagrams like the ones in the magazines.

- Runs under Windows 3.1 making full use of Windows features such as on-line help.
- Full control of appearance including line widths, fill styles, fonts, colours.
- Automatic wire routing & dot placement.
- Fully automatic annotator.
- Complete with device and comprehensive package libraries for both through hole and SMT parts.
- Advanced route editing allows deletion or modification of any section of track.
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CADPAK FOR WINDOWS £ 149
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TWIN-BEAM INFRA-RED ALARM

MAX HORSEY

PCB DESIGN BY TOM STEELE

Twin-beam coverage of any opening improves security and offers fewer false alarms.

This article is based on the information provided in *Teach-In* Part 9, and shows how modules may be selected and combined to produce a working project.

The Twin-Beam Infra-Red Alarm system is intended to connect to an alarm panel, such as a commercially produced house alarm system, or the alarm system featured in *Teach-In* Part 2. It can, though, be used on its own without modification.

The system has been designed to protect against entry through a window or door, without having to close either of them (what a boon for hot days and nights!). It is also especially useful for detecting movement through a passage.

Both the Transmitter and Receiver units have built in voltage regulators, and can operate on a supply of 9V to 15V d.c. Many commercial alarm panels include a 13.8V output suitable for powering this design. The Receiver features a reed relay output which is normally closed, and is compatible with virtually all commercial alarm systems.

WHY TWO BEAMS?

Using a twin beam system allows the design to be more specific in its operation than a standard passive infra-red (PIR) unit. Here *two* beams have to be broken at the same time for the circuit to be triggered. Furthermore, the beams can be positioned so that animals can move underneath without triggering the alarm.

A single beam system is susceptible to being triggered by flying insects, such as moths. By having two beams several centimetres apart, though, both of which must be broken to trigger the alarm, the system is almost immune to false alarms of this nature. It would be very unlucky if two moths happened to cross the beams at the same moment! (*But remember Murphy's Law! Ed.*)

However, the design may also be built as a single beam system if preferred, and still using the same printed circuit board.



THE PRINCIPLE

Block diagrams for the Transmitter and Receiver units are shown in Fig. 1. The two beams and their associated circuits are labelled A and B, and the timing of their relative waveforms is also shown graphically in Fig. 1.

Although the beam transmission periods are shown as single pulses, each pulse actually represents a short burst of encoded data. By keeping the bursts short, the power consumed is kept to a minimum.

In each transmission cycle, the encoded data for Beam A is transmitted first. Beam B is transmitted immediately after Beam A has finished but has a different code to it. Note that Beam B cannot be transmitted at the same time as Beam A, since the two beams would interfere with each other, and the coded information would be lost.

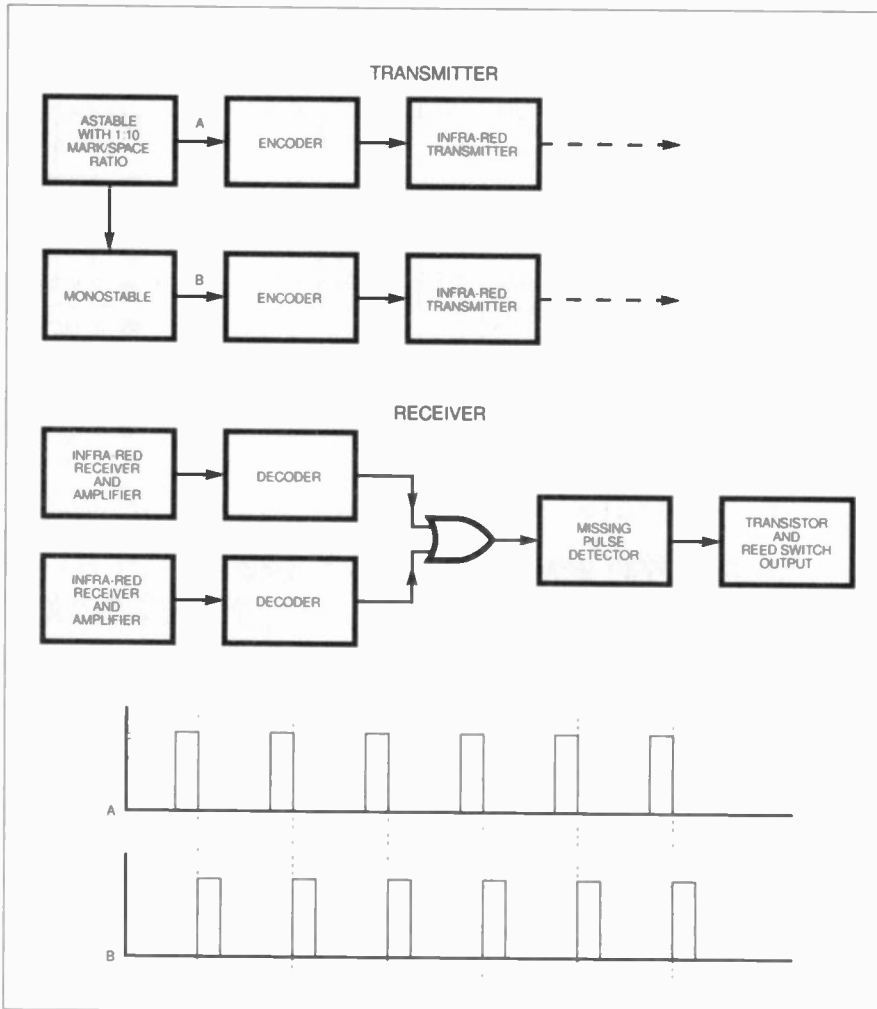


Fig. 1. Block diagrams and waveforms for the Twin-Beam Infra-Red Alarm.

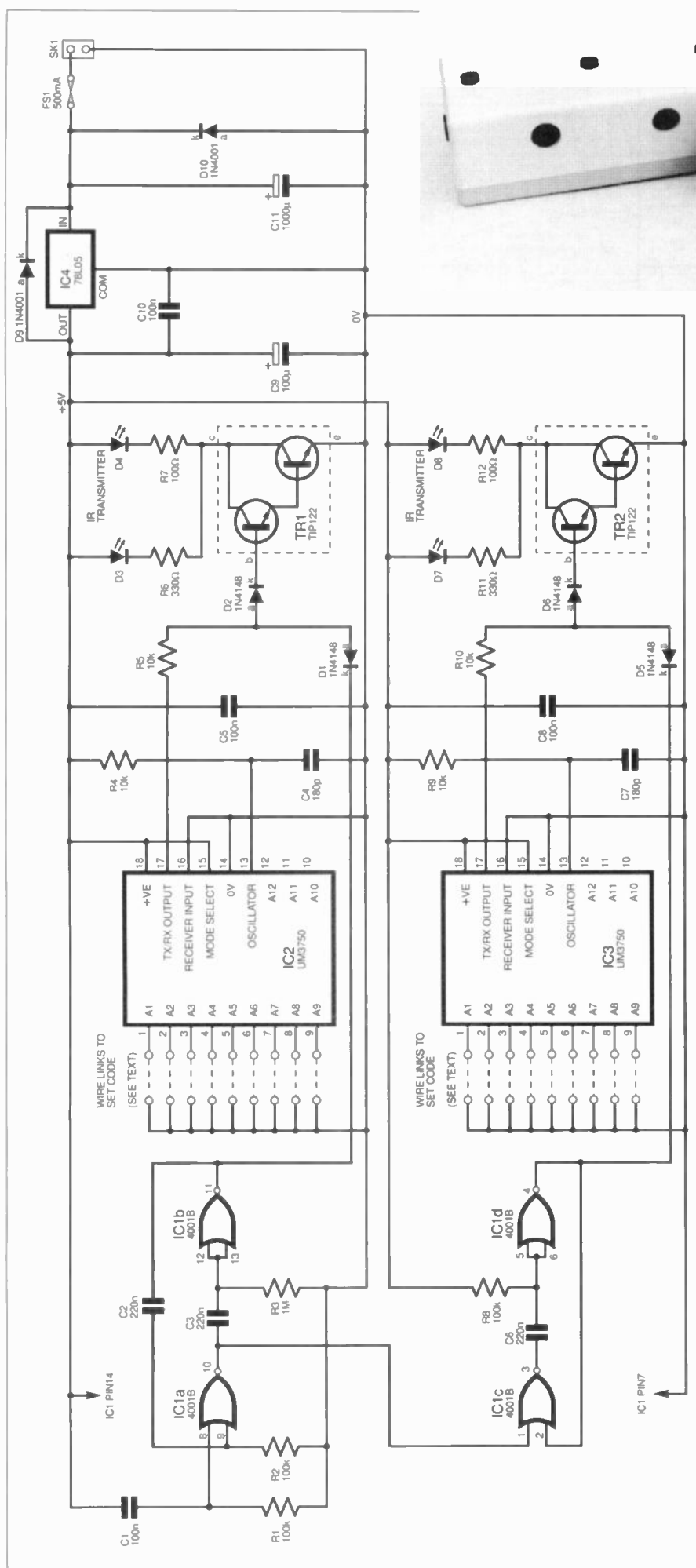
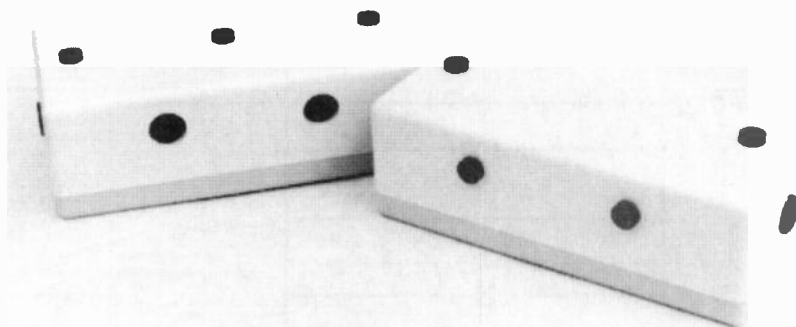


Fig. 2. Circuit diagram for the Dual-Transmitter unit.



The timing control for the Transmitter is formed from an astable which has a 1:10 mark/space ratio. The square wave output from the astable is encoded before being amplified and delivered to a high power infra-red i.e.d.

An inverted signal from the astable is used to trigger a monostable. The monostable is set to produce a positive output of about the same duration as the "mark" signal from the astable. The positive output from the monostable is encoded and amplified in the same way as the astable output.

At the Receiver, both beams are received and processed separately. The incoming infra-red data is first amplified and decoded. The output signals from both decoders are then ORed and fed into a missing pulse detector circuit.

The missing pulse detector is programmed to expect a pulse from one or other of the decoders at regular intervals. If the pulses cease, then both beams must have been broken, and the reed switch output is triggered. This action can be used to activate an audible warning – a bell or a siren, for example. Alternatively, it may be connected to an existing alarm system in a similar way to any of its other sensors.

TRANSMITTER CIRCUIT

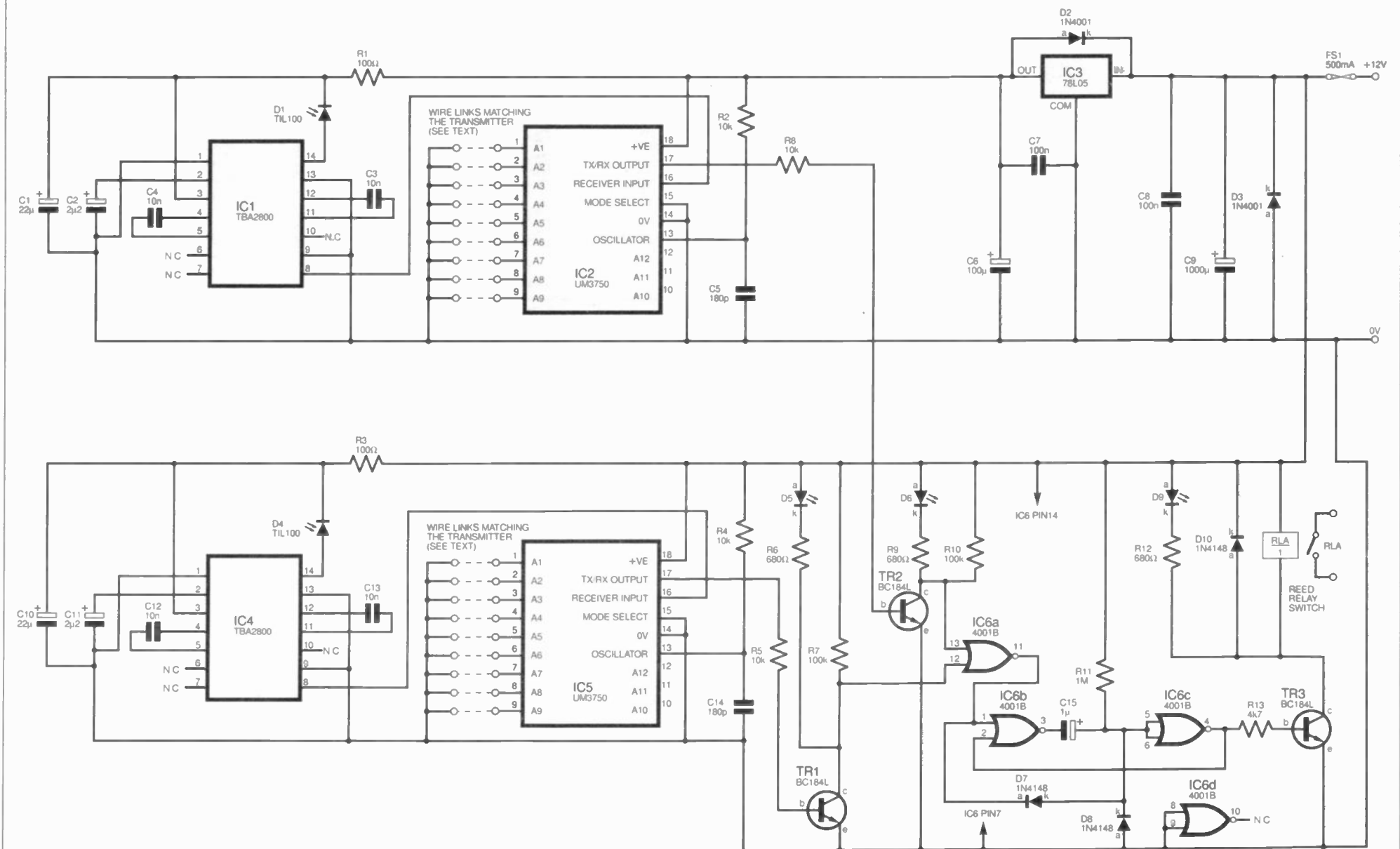
The circuit diagram of the complete Dual-Transmitter is detailed in Fig. 2. NOR gates IC1a and IC1b form the astable, which is a copy of the module discussed in *Teach-In* Part 9. The resistance values of 100kΩ for R2 and 1MΩ for R3 provide the 1:10 ratio output.

Generation of the two encoded signals is performed by the circuits around the data encoder/decoders IC2 and IC3. These parts of the transmitter circuit are based on the module described in Part 5. Apart from the code which they transmit, their operations are identical. The circuit around IC2 is the one we shall discuss in detail.

Data code selection pins 1 to 12 of IC2 allow a 12-bit digital code to be set up by connecting a selected combination of them to the ground (0V) line. The p.c.b. allows any combination of pins from 1 to 9 to be connected to 0V. Unrequired pins should be left open-circuit (unconnected) – they are internally biased and the chip regards them as being high (logic 1).

The coded signal is delivered via resistor R5 and diode D2 to the Darlington transistor pair within TR1. This high gain, high power device turns on both the normal i.e.d. D3, and the IR transmitter i.e.d., D4, subject to control by the astable.

Fig. 3. Circuit diagram for the Dual-Receiver module.



When the output from the astable, IC1b pin 11, is high no current flows through diode D1, and so the coded output signal from pin 17 of IC2 is allowed to flow into the base (b) of TR1 via R5 and D2. When the output from the astable switches low, the coded signal is drained via D1 into the astable output, R5 limiting the current drawn from IC2 pin 17. Diode D2 compensates for the voltage drop across D1, to ensure that the Darlington pair is fully switched off when it should be.

MONOSTABLE

Whenever the astable output (IC1b pin 11) goes low, its inverted output (pin 10) switches high. This output is connected to IC1c pin 1 and controls the triggering of the monostable, which is comprised of IC1c and IC1d. The monostable's timing period is set for about the same time as the "mark" period of the astable.

The output from the monostable (IC1d pin 4) is used to control the second encoder, formed around IC3. This encoder should be set to have a different code to IC2 by connecting to 0V a different combination of pins 1 to 12.

POWER SUPPLY

The external power supply is input via socket SK1 and fuse FS1. It is then regulated down to 5V by IC4. Although the UM3750 devices (IC2 and IC3) can handle a supply voltage up to a maximum of 11V, in order to ensure a stable power line, it was felt preferable to power the circuit from a regulated 5V supply.

The power supply input voltage range in this circuit is from about 8V to 15V d.c., making the unit ideally suited to house alarm systems. Diode D9 ensures that the voltage on the output side of the regulator can never be much greater than the voltage at the input. This could happen due to charges on the capacitors if the alarm

system were to be switched off. Diode D10 prevents damage to the circuit if the supply is accidentally reversed; in this event, fuse FS1 will blow.

Capacitors C5 and C8 to C11 perform general power line decoupling.

RECEIVER CIRCUIT

Details of the complete Dual-Receiver circuit are shown in Fig. 3. The infra-red receiver/amplifier stages used for both incoming signals are identical (IC1 and IC4) and are formed around the module described in Part 5, as was the module for the two decoder stages (IC2 and IC5).

Remember that the code set for IC2 of the Receiver by means of wire links must be the same as the code set for IC2 on the Transmitter. Likewise, the code set for IC5 of the Receiver must agree with that set for IC3 on the Transmitter.

MISSING PULSE DETECTION

Output pin 17 on each decoder (IC2 and IC5) is normally high (logic 1). Taking IC2 as an example, the positive logic level from pin 17 is fed via current limiting resistor R8 into transistor TR2, so turning it on. In this condition, TR2's collector (c) voltage will be near zero, thus l.e.d. D6 will be on and the logic level into the NOR gate IC6a will be low.

When the correct code is received by IC2, pin 17 switches low. TR2 therefore switches off and the voltage on its collector rises to equal the supply voltage. Resistor R10 ensures that this voltage can rise sufficiently, irrespective of the voltage drop across the l.e.d., to ensure that NOR gate IC6a regards the voltage as logic 1.

The same sequence of events applies to TR1 and its associated components. Note that l.e.d.s D5 and D6 will be lit when the code is *not* received.

Provided that pulses are being received by either or both sections of the circuit, the collector of TR1 and/or TR2 will keep switching between logic 1 and logic 0. Whenever either input of the NOR gate IC6a goes high, its output from pin 11 goes low, so discharging capacitor C15 via diode D7.

With IC6c pins 5 and 6 low, the output from its pin 4 will be high. Transistor TR3 will therefore switch on, causing reed relay RLA1 to also turn on. This represents the "normally closed" non-alarm condition.

If no pulses are received by either part of the circuit, the output from IC6a will go high, triggering the monostable comprised of IC6b and IC6c. After an interval determined by the values of resistors R11 and capacitor C15, the output from the monostable at IC6c pin 4 will go low, turning off TR3 and causing the relay contacts to open.

Transistor TR3 is shown as an *npn* transistor. However, it is possible to use a *pnp* transistor instead so that the relay contacts are open when the code is being received, and closed when the beams are broken. This change is described later.

COMPONENTS

TRANSMITTER

Resistors

R1, R2,		
R8	100k (3 off)	
R3	1M	
R4, R5,		
R9, R10	10k (4 off)	
R6, R11	330Ω (2 off)	
R7, R12	100Ω (2 off)	
All 0.25W 5% carbon film or better.		

See

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Capacitors

C1, C5,	
C8, C10	100n ceramic disc (4 off)
C2, C3,	
C6	220n ceramic disc (3 off)
C4, C7	180p ceramic disc (2 off)
C9	100μ elect. radial, 16V
C11	1000μ elect. radial, 25V
Voltages are minimum working values	

Semiconductors

D1, D2,	
D5, D6	1N4148 signal diode (4 off)
D3	l.e.d., yellow
D7	l.e.d., green
D4, D8	infra-red l.e.d., high power (2 off)
D9, D10	1N4001 rectifier diode (2 off)
TR1, TR2	TIP122 or TIP121 <i>nnp</i> Darlington transistor (2 off)
IC1	4001B quad NOR gate
IC2, IC3	UM3750 encoder/decoder (2 off)
IC4	78L05 regulator, 5V 100mA

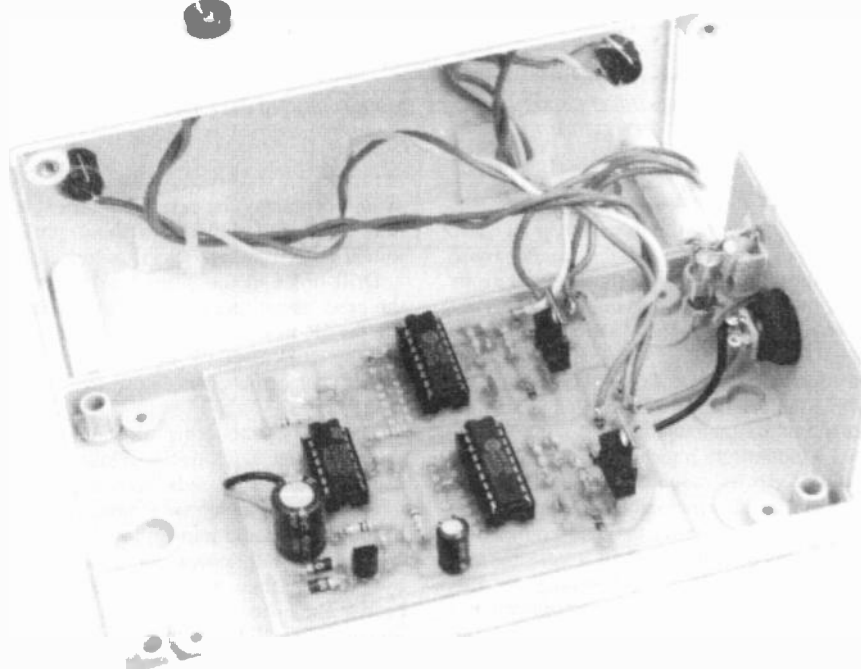
Miscellaneous

FS1	Fuse, 500mA 20mm, and chassis-mounting fuseholder
SK1	Power supply socket
Printed circuit board, available from the <i>EPE PCB Service</i> , code 102; plastic case, 150mm x 80mm x 50mm deep; 1mm terminal pins; clips for l.e.d.s (4 off); 14-pin d.i.l. socket; 18-pin d.i.l. socket (2 off); self-adhesive cable ties; self-adhesive p.c.b. clip; connecting wire; solder etc.	

Approx Cost
Guidance Only

£23

Housing of the IR Transmitter.



POWER SUPPLY

Since the IR receiver/amplifier devices IC1 and IC4 must not be operated on a supply of more than 5.5V, a regulated supply is essential. Power for the circuit can be taken from the household alarm system's power supply. It is then regulated down to 5V by IC3. The other components associated with the power supply work in a similar way to those for the Transmitter.

CONSTRUCTION

Since the construction of the Transmitter and Receiver are similar, both p.c.b.s will be discussed in this section. Their details are shown in Fig. 4 and Fig. 5, respectively. They are available, as a pair, from the *EPE PCB Service*, code 102/3.

Begin by checking that the p.c.b.s will fit into the required case. It is much easier to trim the boards at this stage, than later.

Next insert the d.i.l. (dual-in-line) i.c. sockets and the small wire link on the Receiver board (but not the wires linking the p.c.b.s with l.e.d.s etc.). The wire links to set the codes are discussed later.

Fit the smallest components first, such as resistors, then diodes – the correct way round, followed by capacitors, ensuring that the larger electrolytic types are also inserted the correct way round. Check that transistors are fitted correctly with the flat sides as shown and be careful not to mix up the transistors and 5V regulator i.c.s, since they are of a similar appearance.

The reed relay may be fitted either way round. Fit terminal pins for all the external connections.

Note that IR l.e.d.s sometimes have a longer cathode (k) lead, the opposite to that shown in Fig. 4 and Fig. 5. If in doubt, ask your supplier.

SETTING THE CODES

Use single wire links (for now) to set the codes on the Transmitter and Receiver. The layout diagrams show example positions for the links. Note that the codes set on IC2 and IC3 of the Transmitter must be different from each other, but that the same codes must be copied on the Receiver, i.e. Transmitter code IC2 = Receiver code IC2; Transmitter code IC3 = Receiver code IC5.

When the system is working, extra links can be added to set a unique code.

THE CASES

It may be best at this stage to fit the circuits into their respective cases, since testing is very difficult if the infra-red transmitting and receiving transducers are not secured. In fact, the system is unlikely to work until these devices are correctly positioned in situ.

Cases measuring 150mm × 80mm × 50mm deep were used for both the Transmitter and Receiver. It is vital that the transmitting IR l.e.d.s match those of the receiver regarding position and height etc. Since the Receiver is more difficult to arrange than the Transmitter, it is best to deal with the Receiver first. The transmitting l.e.d.s can then be placed in suitable matching positions on the Transmitter.

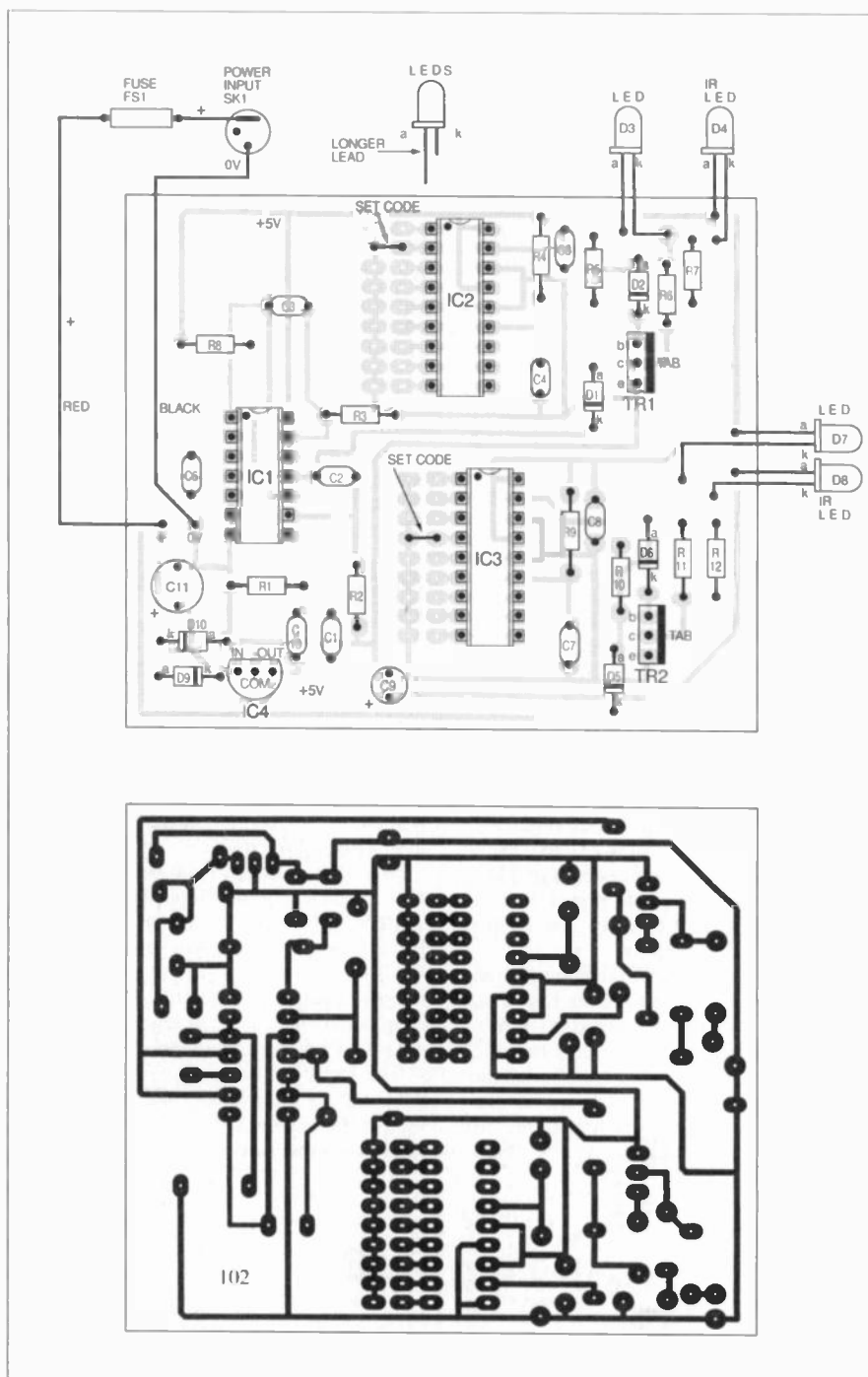


Fig. 4. Transmitter printed circuit board component layout and full-size underside copper foil master track pattern.

RECEIVER CASE

When arranging the Receiver in its case, remember that the infra-red beams must pass through the inside of the case from each hole to the receiving diodes. This arrangement makes the system more directional. Red lenses were tried in the prototype, but plain holes were found to work better! Ensure that there are no obstructions, such as the tops of capacitors etc., which might interrupt the beam.

The p.c.b. is mounted at the bottom of the case as shown in the photograph, allowing the IR beams to pass unimpeded from holes to sensors. Drill a hole for the power supply socket and a hole for the external alarm wires to link with the p.c.b.

Three holes are required in the front for the l.e.d.s. Do not drill any of these holes directly in line with the IR beams. Two terminal pins are needed for the relay

switch contacts. The external alarm system may be joined directly to these pins, or joined via terminal blocks if preferred.

Drill holes at the side, near the top of the case, about one centimetre in diameter for the IR beams to penetrate. Red lenses may be stuck over the holes but, as stated earlier, performance is likely to be better without.

The chassis-mounting fuseholder in the prototype was stuck to the side of the case using self-adhesive pads. Note that a panel mounting fuseholder may project too far inside the case and interrupt the beam.

The infra-red sensors may be mounted by pushing their wires through self-adhesive cable-tie supports. Check that the sensor wires cannot become short-circuited. The self-adhesive supports can then be stuck opposite the holes so that the flat side of each sensor faces into the case.

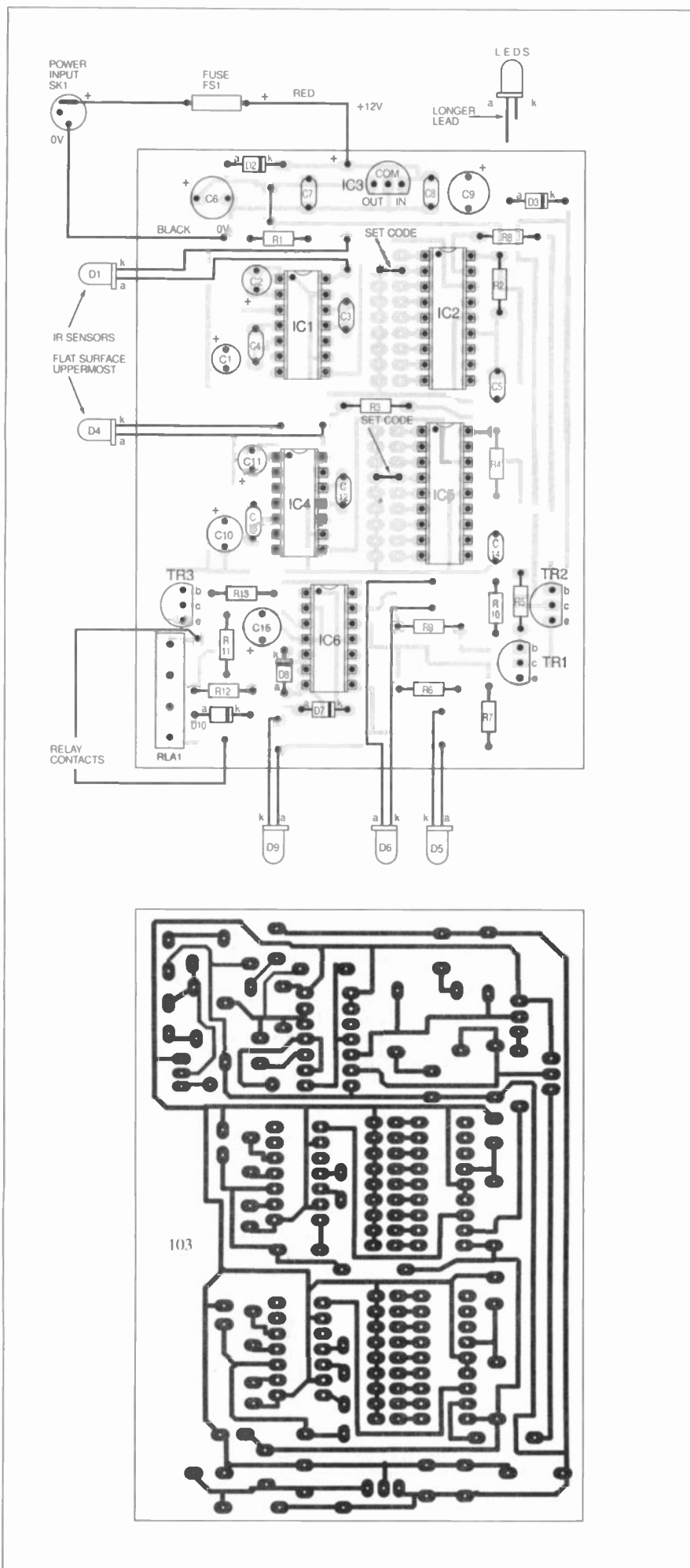


Fig. 5. Receiver printed circuit board component layout and full-size underside copper foil master track pattern.

COMPONENTS

RECEIVER

See

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Resistors

R1, R3 100 Ω (2 off)
R2, R4,
R5, R8 10k (4 off)
R6, R9,
R12 680 Ω (3 off)
R7, R10 100k (2 off)
R11 1M
R13 4k7
All 0.25W 5% carbon film or better

Capacitors

C1, C10 22 μ elect. radial, 16V
(2 off)
C2, C11 2 μ 2 elect. radial, 16V
(2 off)
C3, C4,
C12, C13 10n ceramic disc (4 off)
C5, C14 180p ceramic disc (2 off)
C6 100 μ elect. radial, 16V
C7, C8 100n ceramic disc (2 off)
C9 1000 μ elect. radial, 25V
C15 1 μ elect. radial, 16V
Voltages are minimum working values.

Semiconductors

D1, D4 TIL100 infra-red sensor, or
similar (2 off)
D2, D3 1N4001 rectifier diode (2 off)
D5, D6,
D9 I.e.d. (3 off), one of each
colour
D7, D8,
D10 1N4148 signal diode (3 off)
TR1 to
TR3 BC184L *n*pn transistor
(3 off)
IC1, IC4 TBA2800 infra-red amplifier
(2 off)
IC2, IC5 UM3750 encoder/decoder
(2 off)
IC3 78L05 regulator, 5V 100mA
IC6 4001B quad NOR gate

Miscellaneous

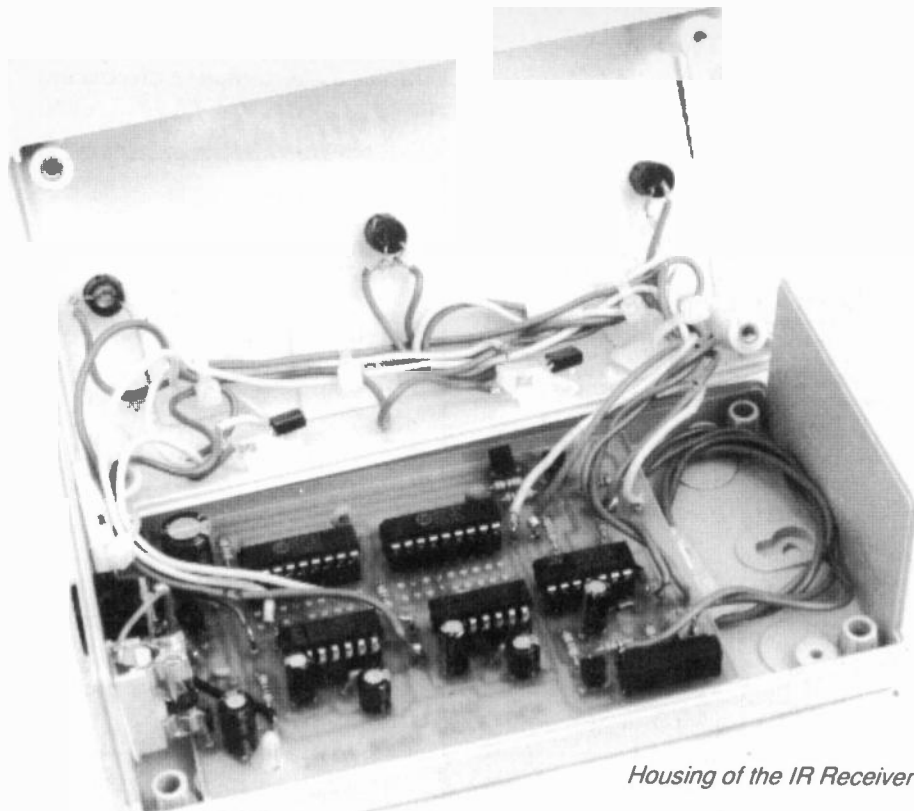
FS1 Fuse, 500mA 20mm, and
chassis-mounting
fuseholder
RLA Reed relay, 12V
Printed circuit board, available from
the EPE PCB Service, code 103; plastic
case, 150mm $\times$ 80mm $\times$ 50mm deep;
1mm terminal pins; clips for I.e.d.s (5
off); 14-pin d.i.l. socket (3 off); 18-pin
d.i.l. socket (2 off); self-adhesive cable
ties; self-adhesive p.c.b. clip; connecting
wire; solder etc.

Approx Cost
Guidance Only **£ 32**

Take great care with all the wires, since they could obstruct the infra-red beams. Either keep the wires very short, or make them long enough to route carefully around inside the case, using self-adhesive pads to stick them in position. Finally, plug in the i.c.s, ensuring that they are fitted the correct way round.

TRANSMITTER CASE

The Transmitter p.c.b. is designed to fit at the base of the case as can be seen in the photograph. Drill holes in the sides for the infra-red I.e.d.s, taking special care to line them up with the sensor holes in the Receiver. Drill holes in the front for the ordinary I.e.d.s. The IR I.e.d.s are 5mm round, and these and the ordinary I.e.d.s will fit neatly into I.e.d. clips if desired.



Housing of the IR Receiver.

Drill holes suitable for a power supply socket and panel fuseholder if required.

Use colour coded wires to link all the l.e.d.s to their respective terminal pins and fasten the p.c.b. with self-adhesive supports. Finally, plug in the i.c.s ensuring they are fitted the correct way round.

TESTING

Testing infra-red systems can be frustrating since it is hard to establish which unit is at fault – unless with extreme good fortune the system works correctly the first time!

Connect a power supply to the Transmitter and check that the ordinary l.e.d.s blink. If all is well so far, connect the Receiver to a power supply. Its l.e.d.s D5 and D6 should light up. This shows that the code is not being received. Place the Receiver a metre or so away from the Transmitter and in line with it.

The Receiver l.e.d.s D5 and D6 should blink off repeatedly if the code is being received. Some adjustment of the relative positions of the two units may be necessary, and try to avoid allowing the IR beam to reflect off nearby surfaces. Moving the Transmitter and Receiver further apart may be helpful, but alignment may then be more difficult.

When either or both l.e.d.s D5 and D6 are blinking off, l.e.d. D9 should turn on, showing that the relay has been activated. Its contacts will now be closed, i.e. in its non-alarm condition.

Breaking one or other infra-red beam will cause D5 or D6 to stop blinking off, but D9 should remain lit. However, breaking both beams should cause D9 to switch off. There will be a short delay before this happens. This delay may be reduced by decreasing the value of resistor R11 if necessary.

FAULT FINDING

If you find difficulties getting the unit to work, read the general fault finding guide in *Teach-In* Part 1. If the *Infra-Zap* project

from Part 5 has been constructed, its Transmitter may be used if the code selected is the same as one or other codes on the Receiver for this alarm. This will establish whether the Transmitter or Receiver is at fault.

If the *Infra-Zap* is not available, then a TV or video recorder remote control transmitter could be used to establish whether the amplifier section of the Receiver is working. An oscilloscope is necessary for this, and a small signal should be present at input pin 14 of both IC1 and IC4. A larger signal should be present on pins 8 of IC1 and IC4 if the two amplifiers are working. The code will not be recognised by IC2 and IC5, of course.

An oscilloscope will also display whether a coded signal exists in the Transmitter at pins 17 of IC2 and IC3. The same signal should exist at the point where diodes D1 and D2 join (and D5 and D6) but the signal will be in short bursts, as pins 11 and 4 of IC1 switch between positive and 0V. In the absence of an oscilloscope, a voltmeter should just register the pulses at these pins.

The logic section of the Receiver is easier to test with just a voltmeter. Reception of the correct code by the Receiver should cause pins 17 of IC2 and IC5 to switch to about 0V.

It may be easier to test the logic section of the Receiver if IC2 and IC5 are

removed from their sockets. Pin 17 on the sockets can now be made positive or 0V as required. For example, if pin 17 of the socket for IC5 is temporarily connected to 0V, the collector of TR1 should switch to positive and l.e.d. D5 should switch off. This should cause pin 12 of IC6a to become positive, and pin 11 to switch to 0V. IC6c pins 5 and 6 should also register 0V and this will cause pin 4 to be positive. A similar sequence of events should occur by taking pin 17 of the socket for IC2 to 0V. Follow the circuit diagram through, checking that the results are as expected.

Repeat the tests above, but now make socket pin 17 positive. The appropriate l.e.d. should light, and after a short pause, pin 4 of IC6 should switch from positive to 0V.

INTERFACING

If the beam break system is used with a house alarm panel, then the alarm panel should have an auxiliary power supply of about 12V (or often 13.8V) available for both units. Having connected the power supply, connect the relay contacts to a spare normally-closed input on the alarm panel.

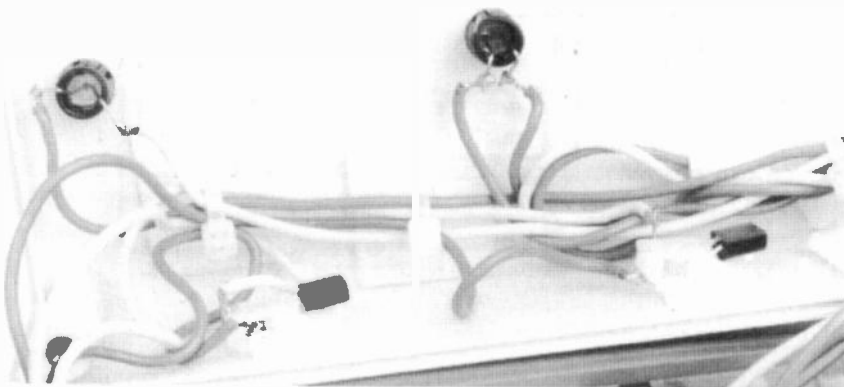
OUTPUT INVERSION

As described, the relay contacts are closed when the beams are received. Some applications may require the opposite. For example, if you want a beeper to sound whenever the beams are broken, or if you wish to interface the circuit with a counter (such as the types described in Part 6), then it is easier if the relay contacts are open when the beams are received, but close when the beams are broken.

There is more than one way to achieve this, but the simplest – even though it is a slight fudge – is to replace TR3 in the Receiver with a *pnp* type, such as BC214L. The leads of a BC214L are in the same order as the BC184L, but the emitter and collector must be swapped on the board, since the collector must now be connected to 0V.

Looking at the transistor as it is shown on the board, i.e. with the flat side on the right and the leads pointing down, the bottom two leads must be swapped round before inserting it into the p.c.b. Be careful that the leads do not short together.

With the output inverted so that the relay contacts are normally open, you can if you wish, use the system on its own, having a bell or alarm sounder wired to the relay. Power can be supplied by a 12V battery – a car battery, for example. ☐



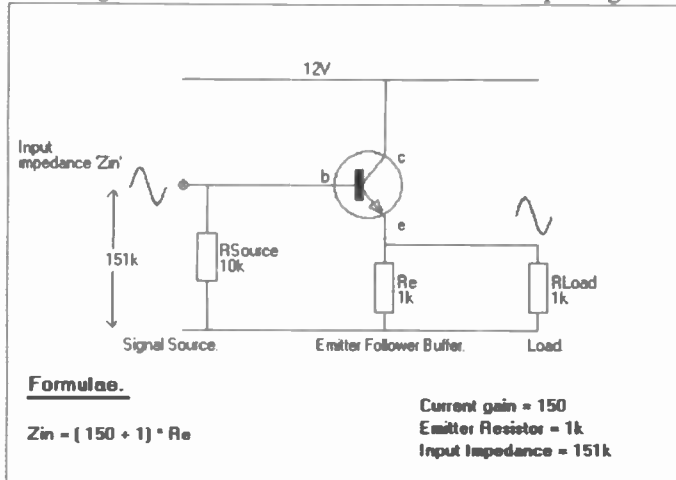
Close-up detail of the Receiver's sensors and l.e.d.s and their mounting.

ELECTRONICS PRINCIPLES 3.0

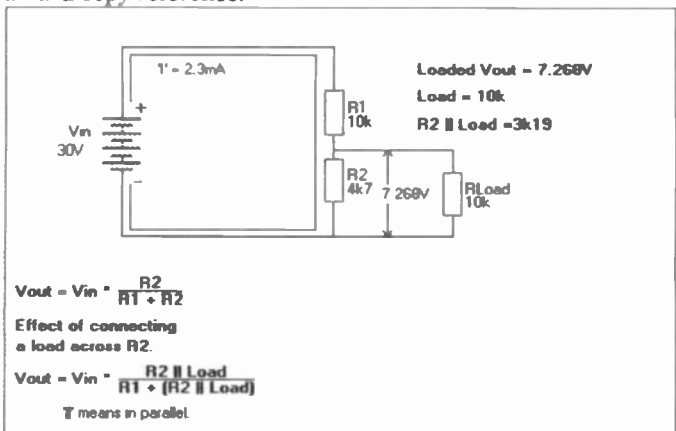
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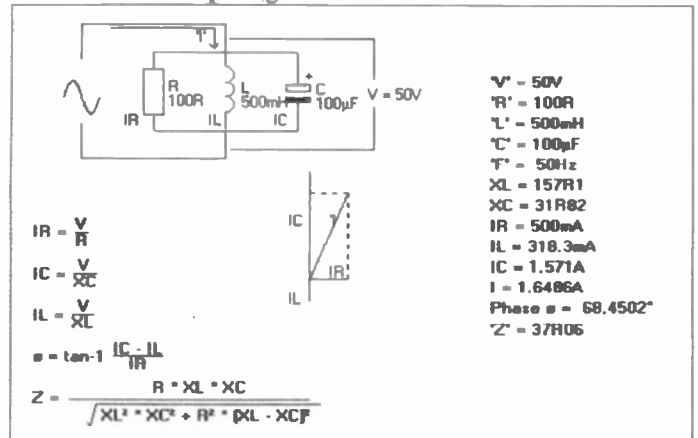
The software is completely self-contained, explanatory text and calculations are laid out in additional Windows, enabling you to see the effect of changing component values, one-at-a-time within the formulae. Graphics, text and calculations can be 'pasted', in colour into text documents for a hard copy reference.



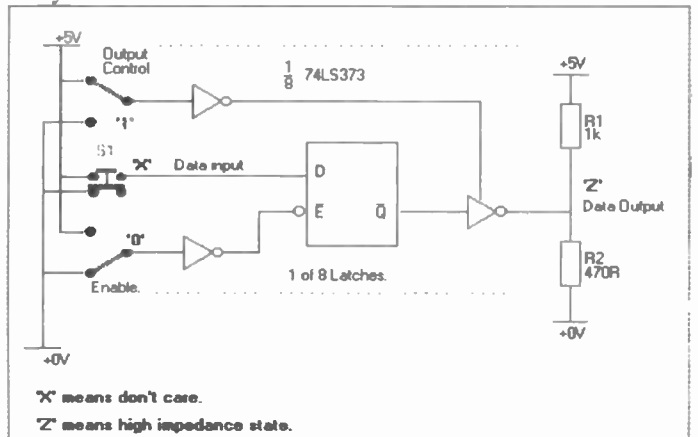
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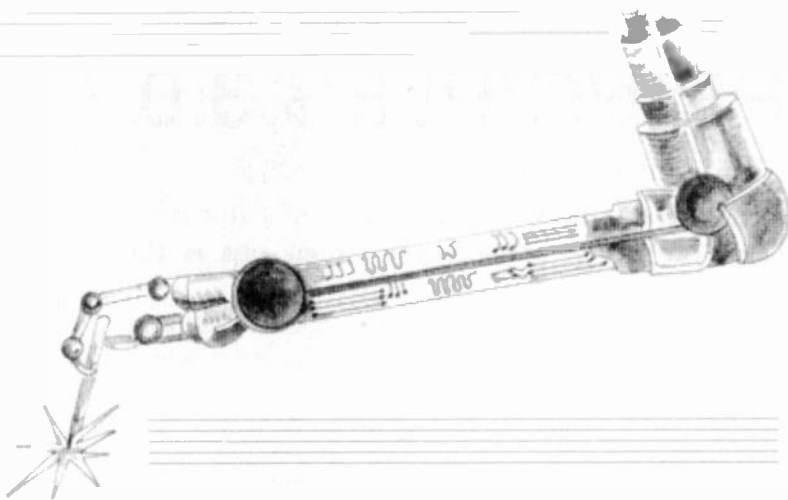
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CIRCUIT SURGERY

ALAN WINSTANLEY



Back to its monthly pole position, the Surgery deals with the highly topical subject of PIC-based constructional projects, more on the Auto Battery Charger project and a quick look at stripboard ratings.

Double Whammy!

IT'S GREAT to be back in my regular monthly slot and, as an added bonus, you'll see that our popular *Ingenuity Unlimited* column featuring readers' own circuit ideas, will now generally appear monthly, as well. We feel sure you'll welcome the extra "Surgery", plus the added opportunity to express your ingenuity too! *Circuit Surgery* is our two-way column to help with electronics problems whenever we can, as well as passing on useful circuits, views, hints and tips, plus follow-ups related to our constructional projects.

The old-favourite *Ingenuity Unlimited* or the "IU" column as we call it, allows readers to share their circuit suggestions with the rest of the readership. IU is a surprisingly difficult column to compile (read the "Take Note" panel of IU this month, for one reason why) and, space being limited, it's a tough decision having to select the successful entrants. I hope that *Ingenuity Unlimited* feature will entertain and encourage you, just as it did myself as a schoolboy, over 20 years ago.

Take Your PIC

A brief note from a reader set me thinking. Firstly, my thanks to Mr. I. Scott-Young of Bulwell, Notts, who asks:-

Dear Circuit Surgery, Can you supply PIC op-codes? Also, there must be many readers like myself who have no access to IBM PCs, so can you use the Internet? Thanks!

I'll try to answer that shortly, and thanks also to reader Martin Gulbrandsen, in Norway, who sent in an E-mail:

Hi Alan, I've a question about the "PIC-DATS" constructional project in the May and June 1995 issues: I want to build a slightly modified (read: expanded) version of the project, but the article hid all the programming secrets into a ready-programmed chip. Could you please help me with the programming procedure? I desperately need the exact specifications: PICs are programmed with TTL-levels together with a 12V to 14V programming voltage, but that's all I know.

The easy question (I think) first. Try the excellent *Simple PIC16C84 Programmer*

featured in February 1996's issue, Martin. It's a perfect starting point for PIC-unaware people! We also ran an introductory feature "Understanding PIC Microcontrollers" in March 1995's issue. You need a PC, some modest software, and a little extra hardware connected to the parallel port. Magenta Electronics now have an improved version of the programmer with p.c.b. as a complete kit, see their ad. for details. Unfortunately, you *do* need a PC!

I'm devoting a lot of written space this month to the burning issue of the suitability of PICs in constructional projects. There's no doubt that the advent of the Arizona Microchip "PIC" microcontroller (to name but one brand) is beginning to have a very significant effect on our hobby.

At a stroke, a custom programmed microcontroller (μ C) sweeps away armfuls of logic chips and circuitry, and can be applied to a humungous array of applications, from random number generation to electricity meters to metal detectors! Arizona also produce an excellent range of supportive material leaving little excuse for not using them.

Firstly, the *PIC DATS* (PIC Development & Training System) code isn't openly available. Magenta Electronics retails a complete kit including the ready-programmed chip (see their advert) but for that project, we're unable to distribute the codes because they're not ours to give away! The same is true about the codes for our *MIDI Analyser* project (May 1996) for instance, which is a genuinely marketable product.

Put plainly, a few desirable projects like the *MIDI Analyser* would never see light of day if the designers were expected to allow free access to the complex codes as well. (Purely as an observation, the same used to be said about complex p.c.b. foils, which is another sign of how the hobby is progressing: since copper track patterns have for many years been published in full as a matter of course.)

Your choice

Feedback which I've gleaned from the more advanced American experience of PICs in hobby electronics, would suggest

that readers contemplating PIC projects fall into one of several brackets:

- Advanced readers who are familiar with the PIC instruction set and are equipped to program PICs for themselves.
- Intermediate-level constructors who don't yet have the resources to program the PIC, but would like to understand how they work anyway, and build the project too.
- Readers who have no particular interest in the circuitry or the chip, they simply want to assemble the project and use it. Projects including our *National Lottery Predictor* (Feb. 95) or this month's *Games Compendium* project might appeal to such readers.

We try to ensure we meet the needs of all our readership, and microcontroller applications in our project pages are something we consider carefully, especially as they do not hold universal appeal – yet.

I had an extremely interesting and lively debate in an Internet newsgroup about a year ago, concerning the use of μ Cs at the heart of constructional projects. It would be true to say that those enthusiasts who can already use the PIC instruction set and "blow" chips for themselves, aren't interested in a published PIC project unless all the project's supporting source code etc. is available, because they might wish to alter the functionality of the circuit or "tweak" it for themselves, as Martin's message proves.

It was revealed that without access to the essential codes, these readers have far less interest, if any at all, in building a particular PIC-based project. So everyone misses out.

However, our policy is that we will purchase the codes as part of the article from the designer and then freely offer them to any reader who asks. We think we're the first magazine in this market to do this, and it's a move which some American readers in particular have warmly welcomed.

There is certainly no question of relentlessly pursuing a policy of using exclusive black-box chips which can only be purchased from an individual source. If we did, there would be little point in printing a circuit diagram: just buy in the PIC and follow the inter-wiring diagram, it's all you need! There will occasionally be

exceptions to this rule though, *PIC-DATS* and the *MIDI Analyser* being two of them.

When codes are indeed available, this currently involves mailing you a floppy disk for a small charge to cover admin cost. Our *PIC Electric Meter* (February and March 1996) by our own Technical Editor John Becker is an excellent example.

We are also in the process of building up our World Wide Web and FTP sites, so anyone with Internet access will be able to download any of our available codes as binary files instantly – even yourself in Norway, Martin!

Readers who don't wish to become embroiled in the flow diagrams, instruction listings etc. and who just want to build the project, are equally well catered for since they can again buy the chip direct. So now we hope everyone's happy.

Incidentally, Martin then mailed us some time later:

The Simple PIC 16C84 Programmer project (February 96), was exactly how a microcontroller project should be – really good stuff!

Your opinions are welcomed. Please let us know how you feel.

Auto Battery Charger

Thank you to Mr. Alec Spencer of Stockport, Cheshire who wrote:

Following up on your February column about this project (see April 1995 EPE), I'd like to suggest that a changeover switch could be used to select the charge current, connected across R6 (Low Current) and either a low value resistor or no resistor at all for a higher current. This would enable either low or larger capacity lead acid batteries to be charged, or alternatively, caravan batteries could be recharged quickly, or perhaps trickle charged in the winter.

A neat idea. This project used an op-amp as a Schmitt trigger to monitor the terminal voltage of a lead acid battery and when it dropped below a certain level, it turned on a mains charger until the voltage had risen again. The optional series resistor R6 (approx. 1 ohm, 3 watt) limited the charge current to a nominal 1A, since the project was designed for use with smaller lead acid batteries only. About 2V appears across the resistor with up to 1A flowing through it.

If you wanted to handle larger capacity batteries (e.g. car types) then a higher

charge current may be desirable. The only way you can do this is to uprate all the main P.S.U. components in the charger. Remember that in a full wave bridge-rectified circuit, the true r.m.s. current seen by the transformer secondary is higher than the final d.c. load current.

Consequently the transformer will need a higher rating – for every 1A d.c. output, the transformer must deliver 1.66A r.m.s. So a 3A d.c. output would need a 5A r.m.s. (60VA) winding. The bridge rectifier D1-4 will need to be a higher current type too.

Switching the value of R6 will limit the maximum current used to charge the lead acid battery. The precise resistor values should be chosen from trial and error using the battery in question. Try a 3.3 ohm 2W resistor for a 500mA peak. A simple network giving three charge currents is shown in Fig. 1.

Also, it's worth pointing out that there may be a limit to the current which the p.c.b. can safely carry. The unit was designed for one amp, and this leads me onto the next reader's question.

Stripboard current

Mr K.H. Rutter of Cardigan asks:

Dear Alan, can you tell me what is the maximum voltage and current rating for 0.1 inch stripboard? Why isn't stripboard plated or tinned as printed circuit boards are?

Stripboard (or "perfboard") is no longer the off-the-shelf standard product it once was. There was a time when the proprietary "Veroboard" product had no peers. It came in a range of standard sizes (and pitches: 0.1 inch, 0.15 inch and 0.2 inch at one time, if I recall correctly) which I could virtually recite off by heart. (10 strips $\times$ 24 holes, etc.) but like most things, there are now cheaper imported alternatives as well as p.c.b.s. Why, I once received *white* stripboard which was apparently made in the Far East. Is nothing sacred?

Many years ago there was one alternative system called "Blob Boards" which were pretty gruesome things to solder although they were roller tinned. I guess that tinning stripboard would just have made it too expensive for a cheap and cheerful prototyping product. That's also why old stripboard is hard to solder (tarnishing) unlike a tinned p.c.b.

Standard 0.1 inch stripboard is fine for 250V operation but personally I would tend not to use it to carry more than maybe an amp or two at mains voltage; theoretically the copper strip is rated for 5A depending on other factors (permissible temperature rise for one).

A sensible precaution is to make not one but two adjacent breaks in the strip when needed, just to be sure of completely isolating any mains-voltage tracks. Soldering on a length of tinned copper wire is a "dirty" way of boosting the current carrying capacity, as well as weakening the adhesive...

I'm always keen to ensure that all mains wires, terminals etc. are secured with tie wraps or hot melt glue, to avoid stressing the connections. There's no doubt, a printed circuit board is far superior in such projects, and I often place the entire mains side (mains inlet, fuse, transformer) on the board as well. A good example is my simple *Multi Purpose Thermostat* project featured in *EPE*, March 1995, with my usual style of hand-made board!

Art of Electronics

The *Art of Electronics* is the one "classic" book on electronics I heartily recommend to anyone having anything other than a casual interest in modern solid state electronics. The "Art" by Horowitz and Hill is possibly one of the world's best general electronics textbooks.

The present (2nd) edition has, in my opinion, just the right balance between theory and hands-on experience and teaches electronics as a mixture of understanding, rules of thumb, erudite knowledge, hunches and gut feelings. It isn't a dry work on semiconductor physics and it always has a consistently practical angle.

Electronics fans everywhere have asked whether a "3rd Edition" is looming. In late February '96 a message appeared from a Charles Coldwell in the USA who posted this into the Internet newsgroup *sci.electronics.basics* in reply to this very question: "Paul Horowitz is my thesis advisor. He and Winfield Hill are working on the Third Edition but I don't think it will be out for at least another year now." So now we know.

In the meantime, the *Art of Electronics* (2nd Edition) is still available by mail order from the larger electronics distributors, or bookshops. It contains 1,125 pages, RRP £35.00. Published by Cambridge University Press, ISBN 0-521-37095-7. An accompanying Student's Handbook (ISBN 0-521-37709-9 £16.95) is a useful adjunct. Both texts are listed by Farnell (Tel: 0113 263 6311), order code 171-986 and 171-987 respectively.

Next month: those 555 circuit hints I promised, plus a look at constant current sources.

If you have any questions or any comments to make, please write to Alan Winstanley, *Circuit Surgery*, Everyday Practical Electronics, Allen House, East Borough, Wimborne, Dorset, BH21 1PF, United Kingdom. E-mail: alan@epemag.demon.co.uk. http://ourworld.compuserve.com/home-pages/alan_winstanley.

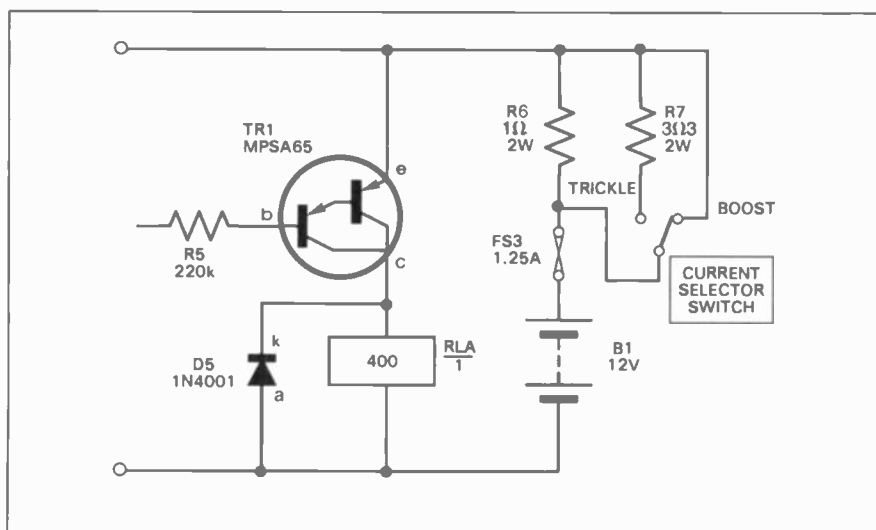


Fig. 1. A simple network for providing three battery charging current ranges.

GAMES COMPENDIUM

JOHN C. BARKER

Eyes down and PIC a number – everyone could be a winner!

THIS project is meant just for fun, not for serious gamblers! It may be used at home or even for fund raising for your favourite club or charity. It consists of four electronic games, Bingo, Dual-Dice, Roulette and Lottery, any one of which can be selected on power up. All the games are displayed on a dual seven-segment light emitting diode (l.e.d.) display.

If Bingo is selected, the display initially shows "HH" (for Housey-Housey – as it used to be called). On each press of the Play button, the display shows a random number between one and 90. Each number is displayed only once. If the last number is reached, it is displayed until the game is turned off.

For Dual-Dice, the display initially shows "dd". Then on each press of the Play button, two random numbers between one and six are shown. The game continues indefinitely until the power is turned off by its switch.

When playing Roulette, "r" is displayed on power up. On each press of the Play button a random number between 0 and 36 is displayed, if that number is a red number the decimal point is also lit. The play continues indefinitely until powered off.

If Lottery is selected, "L" is displayed. Now on each press of the Play button a random number between one and 49 is displayed. Six unique numbers are then selected by pushing the Play button, after which the display again shows "L" and another six selections can be made, *ad infinitum*.

HOW IT WORKS

As can be seen from the circuit diagram in Fig. 1, the Games Compendium design is very simple and consists of a programmed PIC16C84 microcontroller chip, IC1, and a dual common-cathode seven-segment display, X1.

The microcontroller's internal oscillator is configured for RC mode and the clock

frequency is set by resistor R7 and capacitor C1. The clock pulses generated by the oscillator in this mode are less stable in their frequency than would be case if the oscillator were crystal controlled, but in this application, this is unimportant.

Port B of IC1 controls the seven segments and decimal point of each digit in the multiplexed dual l.e.d. display. Port A lines RA0 and RA1 perform the multiplexed switching between the two display digits.

Usually, current limiting resistors would be connected between each line of Port B (RB0 to RB7) and each individual l.e.d. anode. To keep this circuit simple, though, just two current limiting resistors (R3 and R4) are used, one for each display digit, placing it in the cathode path controlled by Port A.

This technique has the benefit of simplicity, but it does mean that there could be a slight difference in brightness between various display readouts, depending on the number of segments lit. In practice, though, the author did not find the difference significant, although the

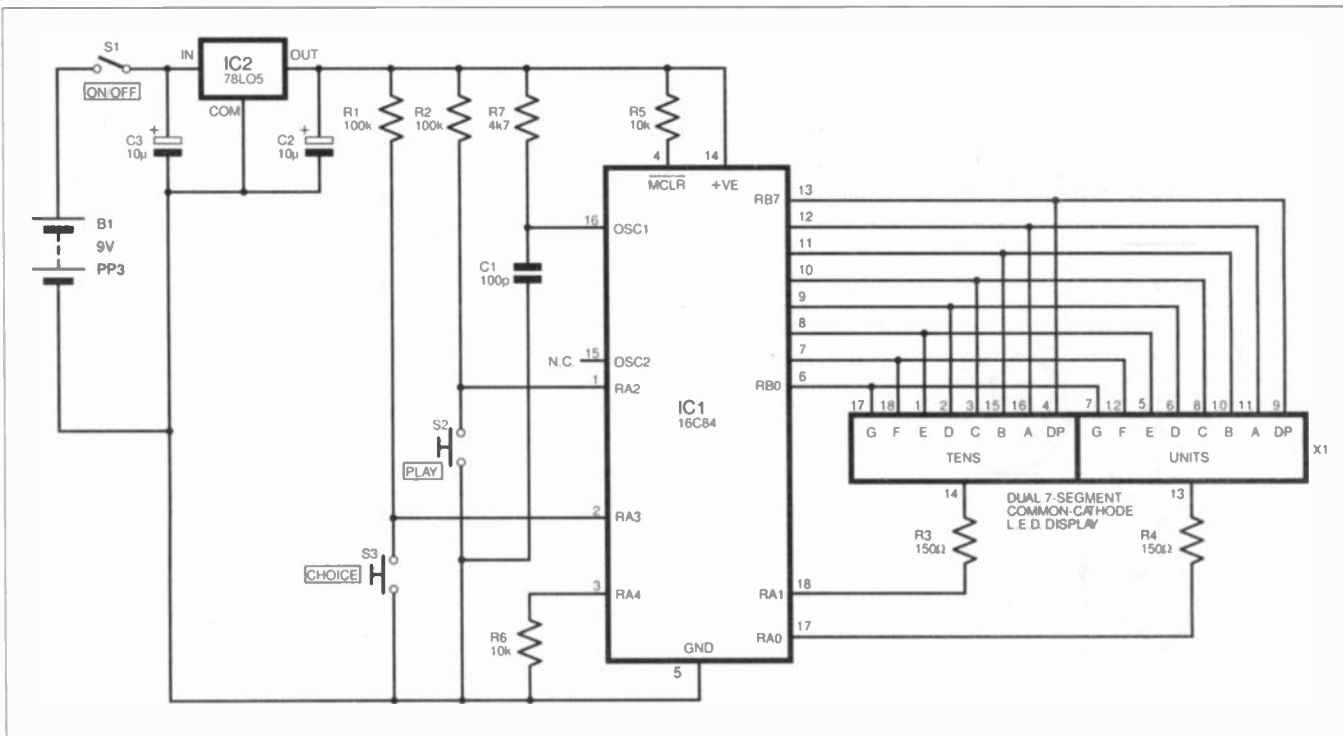


Fig. 1. Complete circuit diagram for the Games Compendium system.

display was not bright enough to play the games in direct sunlight.

Lines RA2 and RA3 of Port A are used for detecting the status of the Play and Choice switches, S2 and S3, respectively. These lines are normally held high via resistors R1 and R2, but go low when the relevant switch is pressed. Software then determines what action should be taken. Line RA4 is not used and is simply grounded via resistor R6.

The MCLR line is held high for normal microcontroller "run-mode" via resistor R5.

Power is derived from a 9V battery, B1, for which a type PP3 may be used. This 9V supply is then regulated down to 5V by IC2. Note that the 9V supply MUST NOT be connected directly to IC1, which has an absolute maximum supply voltage limit of 7V. Capacitors C2 and C3 provide power line decoupling.

SOFTWARE

Because the PIC16C84 microcontroller has only 36 general purpose registers, some of which are used for processing, the numbers chosen for all games (except Dual-Dice) are held in a form of software look-up table, as shown in Fig. 2.

TABLE ASSIGNMENT																MSB		LSB		REG	
7	6	5	4	3	2	1	0	1E	15	14	13	12	11	10	9	8	1F	23	22	21	20
23	22	21	20	19	18	17	16	20	31	30	29	28	27	26	25	24	21	39	38	37	36
31	30	29	28	27	26	25	24	21	47	46	45	44	43	42	41	40	23	55	54	53	52
47	46	45	44	43	42	41	40	23	63	62	61	60	59	58	57	56	25	71	70	69	68
63	62	61	60	59	58	57	56	25	79	78	77	76	75	74	73	72	27	87	86	85	84
79	78	77	76	75	74	73	72	27	87	86	85	84	83	82	81	80	28	—	—	—	—
87	86	85	84	83	82	81	80	28	—	—	—	—	—	—	—	—	89	88	29	—	—

Fig. 2. The software look-up table.

The table consists of the 12 registers \$1E to \$29, each of which has eight bits, making 96 bits available. Taking the bits in ascending order, each one can be regarded as representing one of 96 numbers. Thus, for example, register \$1E bit 0 can represent zero, \$1E bit 7 can be

numeral seven, \$1F bit 1 numeral eight, and so on.

At the start of any game, all these bits are set to zero. Then, in a game situation, the bits associated with the various numbers involved can be set high (logic 1) as appropriate to the game.

For Bingo and Lottery, when a number is chosen, the appropriate register bit is set high to indicate that the number should not be selected again during that game. For Roulette, register bits are automatically set for selected numbers to indicate that they are "red", as on a roulette wheel.

In all the games, a random number is first derived from the PIC's RTCC register, which is a free-running incrementing register whose count value when sampled from software could be any between 0 and 255. The number is then processed to bring it into the required range (Bingo 1 to 90, Lottery 1 to 49, Roulette 0 to 36, Dual-Dice 1 to 6).

For Bingo and Lottery, a check is made to see if the number has already been selected, testing the appropriate register bit to see if it has previously been set. If the number has already been used another one is selected. The chosen number is displayed on the l.e.d. readout.

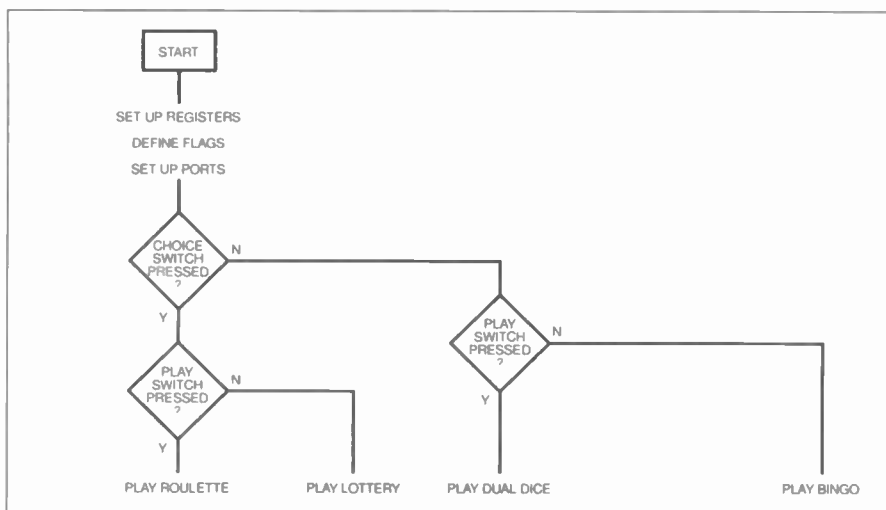


Fig. 3. Games selection flow chart.



The completed Games Compendium. As seen in this photograph, the on-off switch is top right, the Choice switch is top left, and the Play switch alongside the l.e.d. display.

For Bingo, this process is continued until all 90 numbers have been selected, whereupon the game stops. For Lottery, six numbers are selected and displayed, after which "L" is displayed indicating the start of another six selections.

With Roulette, the random number does not have to be unique, but whether it is "red" or "black" must be known. This information is stored in the register table when the game starts, high bits are "red", low bits are "black". During the game, a number between 0 and 36 is chosen and displayed, with the decimal point also turned on if the appropriate register bit indicates that the number is "red".

Dual-Dice just gets a random number, splits it into a high and low nibble (4 bits), which are then limited to the required range (0 to 6) and displayed. The register table is not used in this game.

The software flow-charts in Fig. 3 to Fig. 8 give an insight into the way that the PIC has been programmed to perform the four games.

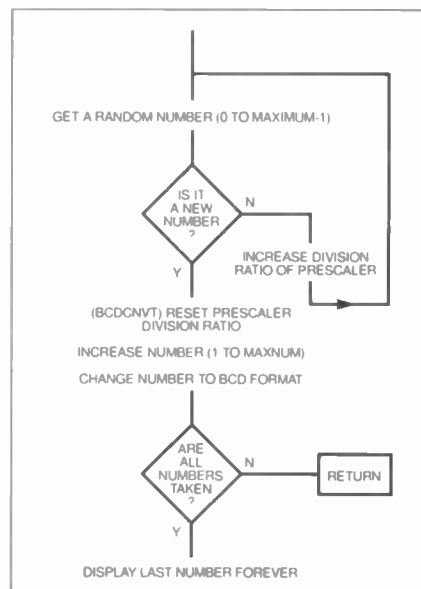


Fig. 4. Flow chart for the GETNUM routine.

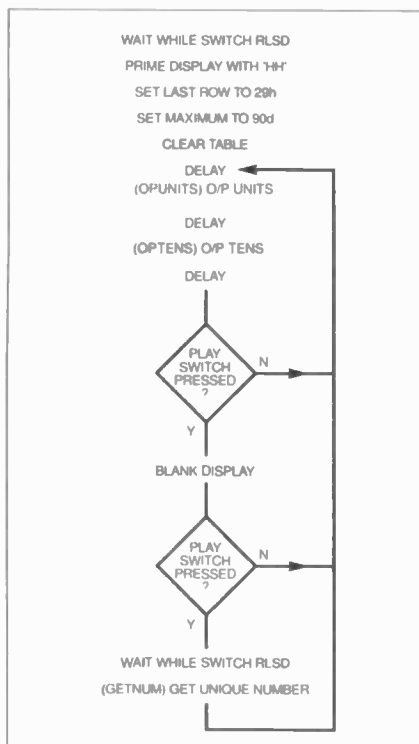


Fig. 5. Flow chart for the Bingo game.

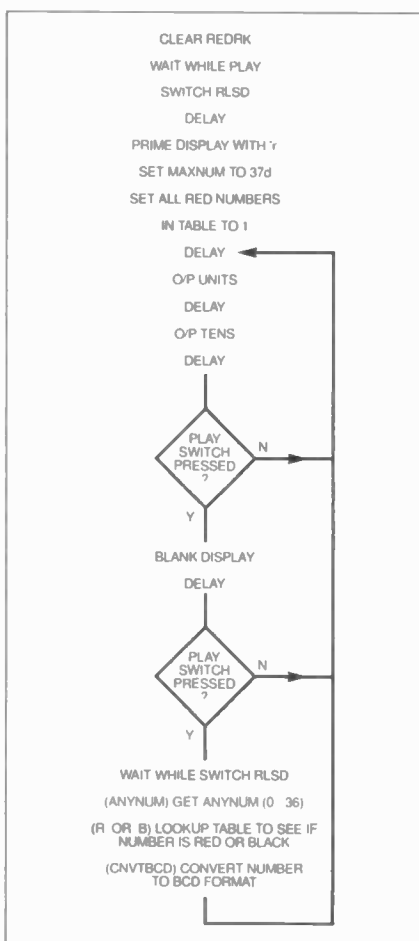


Fig. 6. Flow chart for the Roulette game.

CONSTRUCTION

Details of the printed circuit board (p.c.b.) for the Games Compendium are shown in Fig. 9. This board is available from the *EPE PCB Service*, code 104.

Dual-in-line (d.i.l.) sockets should be used for IC1 and the display X1. The

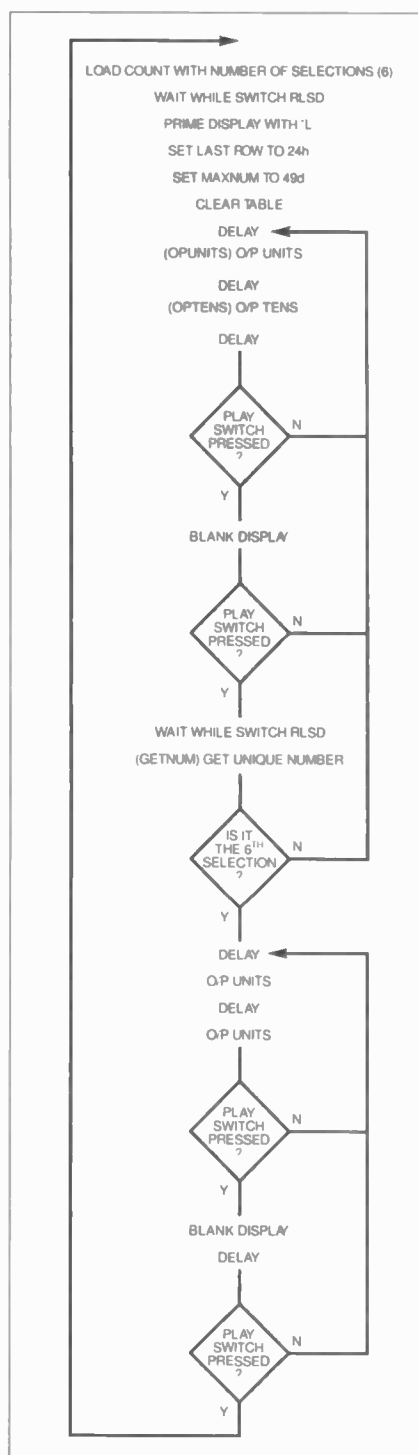


Fig. 7. Flow chart for the Lottery game.

components are best inserted and soldered in order of size, starting with the wire links, four of which go below the socket for the display. Ensure the correct orientation of IC2 and the electrolytic capacitors C2 and C3. Do not insert IC1 or the display yet.

Next make the connections to all the off-board components. Note that switches S2 and S3 should be good quality click-action types, to avoid complications with excessive contact bounce.

Once the board and wiring are complete, check all soldering for dry joints and/or short circuits. Then insert IC1 (pre-programmed – see below) and the display.

To check the operation of the unit, power it up and it should show "HH", for the Bingo game. If this is not shown, immediately switch off the power and check everything again.

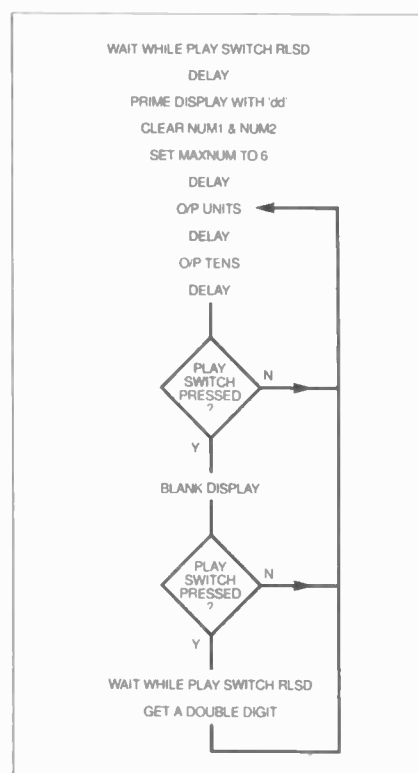


Fig. 8. Flow chart for the Dual-Dice game.

COMPONENTS

Resistors

R1, R2	100k (2 off)
R3, R4	150Ω (2 off)
R5, R6	10k (2 off)
R7	4k7

All 0.25W 5% carbon film.

Capacitors

C1	100p polystyrene
C2, C3	10μ elect. radial 16V (2 off)

Semiconductor

IC1	PIC16C84 microcontroller, pre-programmed (see text)
IC2	78L05 5V 100mA voltage regulator

Miscellaneous

S1	on/off rocker or toggle switch
S2, S3	s.p. push-to-make switch (good quality – see text) (2 off)
X1	7-segment display, dual-digit, multiplexed, common cathode

Printed circuit board, available from the *EPE PCB Service*, code 104; plastic case, 114mm x 76mm x 38mm; 18-pin d.i.l. socket (2 off); PP3 battery and clip; connecting wire; solder, etc.

Approx Cost
Guidance Only

£19

If the unit boots up satisfactorily, the Play button (S2) should be pressed 90 times, and each time a unique number should be displayed, after which the display should freeze. If it is not possible to display 90 numbers before the display freezes, it is almost certainly a problem with the Play switch which is generating too much contact bounce, in which case a better quality component should be used. Only limited provision has been made for

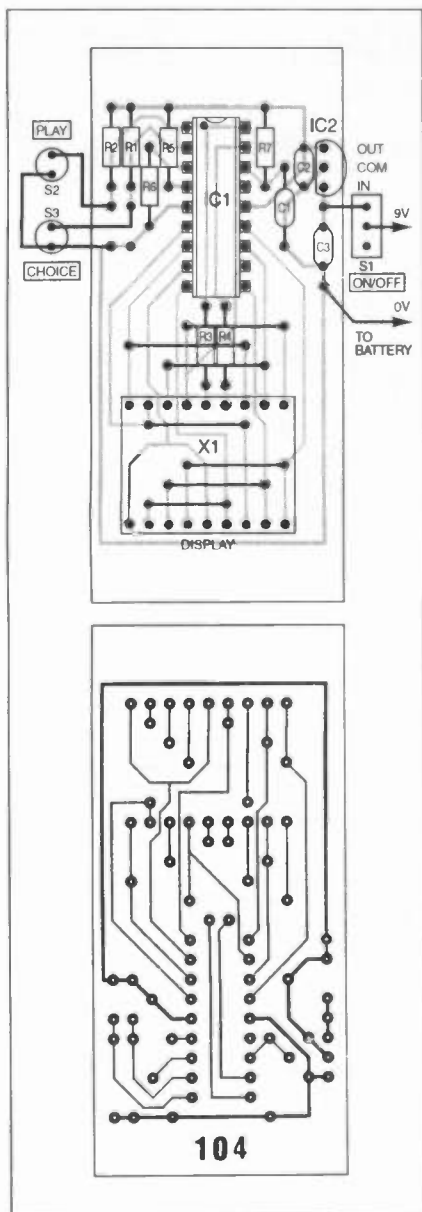


Fig. 9. Printed circuit board component layout and full-size underside copper foil master track pattern.

the software to detect and avoid contact bounce.

On power-up, the game selected depends on which switches are pressed:

None pressed = Bingo
Play pressed = Dual-Dice
Choice pressed = Lottery
Play and Choice pressed = Roulette

When playing any of the games, the Play button should be kept pressed for one or two seconds to randomise the number.

The prototype was fitted in a plastic box measuring 114mm x 76mm x 38mm. The position of the components can be seen in the photographs. The board is secured on angled p.c.b. runners, which are fixed 12mm down from the lip of the box. When the lid is fitted, the p.c.b. is held in place as soon as the display is pushed securely into its square cut-out.

PIC RESOURCES

Before the PIC16C84 will do anything, of course, it needs to be programmed. There are three ways of doing this:

A pre-programmed PIC16C84 is available from the author. He will also be

pleased to program your own PIC16C84 chip if you send it to him. The price of both these offers is detailed in *ShopTalk*.

For constructors who wish to program their own chips, the source code (disk file: 84comp.mag) is available on 3.5in. disk from the Editorial office. This file must be compiled to an object code file (.CBJ), which then needs to be downloaded into the chip using a suitable programmer, such as the *Simple PIC16C84 Programmer* in *EPE* Feb. '96 issue. See *ShopTalk* for these details as well.

ACKNOWLEDGEMENT

The author wishes to extend special thanks to Arizona Microchip who supplied "phenomenal support" for their range of processors via their Internet bulletin board. He also thanks David Tait for writing the software for this project and providing a PIC programmer. □

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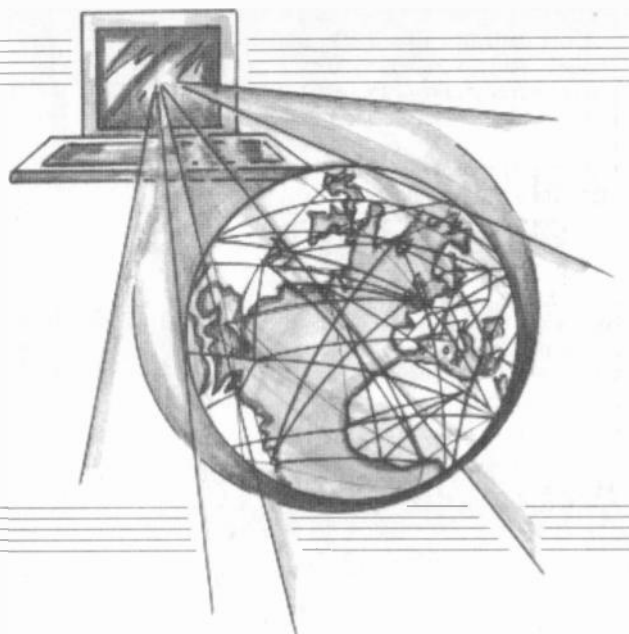
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THE INTERNET

WHAT'S IN IT FOR YOU?

ALAN WINSTANLEY



A fascinating history of the development of the world's most powerful communications system, and present day techniques and systems.

TRACING the history of the development of the Internet, from a network of four American computers, right up to today's estimated 35 million, brings forth some interesting facts.

Surfing Safari

Take a close look at a few recent television advertisements: for example, those promoting Vauxhall Cars, or alternatively a favourite tippie, Guinness. In tiny letters, a solitary string of characters flashes on-screen briefly: <http://www.vauxhall.co.uk> and <http://www.guinness.co.uk>. Or how about Pirelli Tyres: <http://www.pirelli.com>. Even H.M. Government joins in with <http://www.open.gov.uk/inrevlirleaf.htm> which was spotted in a newspaper advert concerning the gripping world of Inland Revenue self assessment of tax. Talking of gripping, try a TV advert for Polycell wallpaper paste, no less, followed by one for IBM Computers: they're all at it!

Even a humble television programme such as *BBC Points of View* mentions that it has an "E-mail address" of pov@bbc.co.uk placed at the disposal of its band of techie viewers. Meanwhile, people ask, "Do you surf the net" followed by "What's your URL?" Yes, the Internet is here, accompanied by a techno-speak language all of its own and supported by a cast of millions. Thirty five million, or so, in fact.

Nowadays it's fashionable to talk about the "Information Superhighway", "E-mail addresses" and "web sites". Indeed, it's positively trendy to have an E-mail address, just as it was to have a fax number ten or twelve years ago. So let's set the record straight in this no-hype, fanatic-free guide as to what the fuss is really all about.

Growth of the Internet

First of all, unlike a telephone system for instance, nobody's really in charge of the Internet as a whole. It's just *there*. The Internet exists as a world-wide collection of computer networks, all hooked together via global communication links, fibre optics and good old copper wire, with the odd satellite orbiting inbetween. Many of these computers access the Internet just for the few minutes of the day that they are "on line". Some other parts of the networks are connected to the Internet permanently.

It's estimated that there are well over 35 million Internet users world-wide, with 100 million or more projected by the end of this century. In the United Kingdom, it's hard to say precisely how many users there are: to offer some idea,

Demon Internet Services of London claim to be the United Kingdom's largest "Internet service provider" having some 60,000 customers, whilst the American company CompuServe Information Systems, with four million customers world-wide, reckoned rather optimistically they would achieve half-a-million customers in the UK by the end of 1996. Excluding individual users in academic and industrial/ commercial networks, I guess there are probably well under half a million UK users or so, but rising – fast.

So how did this thing called the "Internet" come about? One theory points to the launch of Russia's *Sputnik 1* satellite in October, 1957 as the turning point, an event which in its time must undoubtedly have unnerved America's military planners. In the 1960s with the advent of the space race, the US Air Force surmised that their land-based communications systems could be crippled easily in times of war, and therefore they funded some research into developing a safe and secure network which, if damaged during nuclear warfare, could still guarantee that data and information would find its way through by one means or another – even if part of the network had been destroyed.

They reasoned that by ensuring that their communications systems were *dispersed* and never reliant upon one single *central* site, their network was rendered inherently much less susceptible to attack. In the late 1960s, the US Department of Defence directed its Advanced Research Project Agency (ARPA) to analyse and resolve the problem of making military communications invulnerable to military attack and consequently in Summer 1968, the ARPANET – the *ARPA Network* – was created. This consisted of exactly four US academic and research computer sites linked together by telephone lines, see Fig. 1.

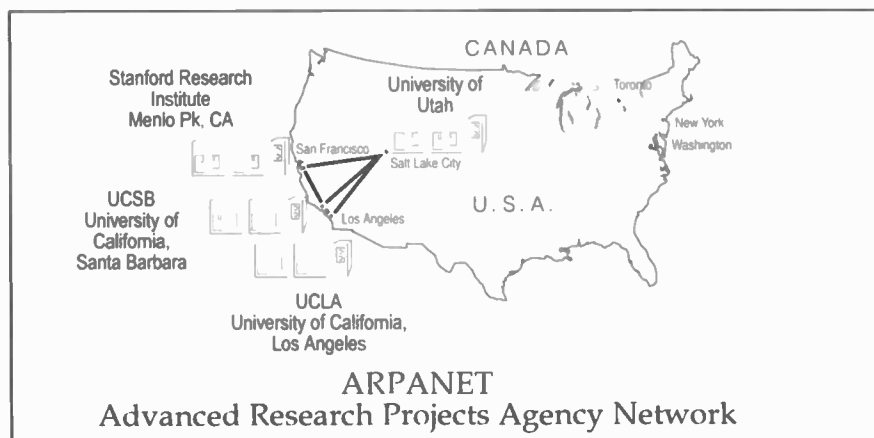


Fig. 1. ARPANET, the original packet switching network.

These particular sites had been chosen because they were computer research centres already known to ARPA whom, it was hoped, possessed the resources to solve some very thorny problems which undoubtedly would lay ahead. In order to meet the demands for a secure communications system, what would be required was a completely different way of *thinking* and a new means of *operating* if the concept of a computer network, connecting several different sites over telephone lines, was to prove a viable system of communicating data. Little did they envisage the colossal impact which their early trials would have on the world's population, some 25 years later.

Packets of Mail

The four sites were all interconnected by a *packet switching system*. Whilst some experiments in computer-based communications had already taken place, the ARPANET differed from earlier experiments in that it used packet switching on a large scale for the first time. The concept of packet switching is said to have been shaped at the National Physical Laboratory (NPL) in the United Kingdom starting in 1968, with ARPANET introducing its own implementation about a year later.

"Packets" are small chunks of the whole message which are transmitted over a communications link and re-assembled upon reception, see Fig. 2. Put simply, each packet has the "address" of the intended destination so they never go astray, and error-checking systems mean that packets can be re-sent over the network if a discrepancy arises in their contents during transmission; the message is guaranteed ultimately to arrive intact. If part of the network is down for any reason (such as war damage or hardware failure) then packets can be re-routed through other operational parts of the network.

A "self-healing", secure communications network was thus proposed: but imagine, ARPA's ideas were completely different from anything else happening at the time, and they started out with nothing except a completely blank sheet of paper.

Packet switching would turn out to be the key to disaster-proof transmissions. ARPANET used specially-built "Interface Message Processor" (IMP) machines based on Honeywell 516s. IMP's were conceived as custom-built peripherals which were to be spliced into their parent mainframe computer, being designed purely for the purpose of communicating on a network. They had some 12K of memory, which was handsome at the time! (Recall that spacecraft *Apollo 11* landed on the moon in 1969 guided by computers which were far less capable than today's average desktop PC.) A computer language called "Unix" was also introduced by Bell Laboratories which was to become the *de rigeur* language for most computer communication networks, right up to the present day.

The very first IMP machine was delivered by sub-contractors BB&N on 30 August 1969, to University of California, Los Angeles (UCLA). The second was delivered to Stanford Research Institute (SRI) that October. The two computers formed the first true packet switching network, from which the Internet would eventually evolve – firstly with a cautious, toe-first dip in the waters and eventually a springboard dive headlong into global connectivity. The two remaining University sites were installed soon afterwards.

At the same time, much effort had gone into the actual computer command structures or "protocols" which were needed to make the computer systems communicate with each other. It is said that the communication interfaces developed on an IMP at UCLA worked first time when the system was powered up, which must have been a very encouraging sign for the developers. ARPANET allowed users at one site to "log in"

2000	100 million users forecast
1996	35 million users. CompuServe lowers prices. UK gains 130+ ISP's. 'Java' language for WWW offers new levels of functionality. Mastercard and VISA agree systems for trading by Internet
1995	Demon offers local-rate dial-in access across UK. CompuServe offers free WWW space to its customers
1992	Est. one million users. Demon Internet Services opens in London. 'Tanner a Month' flat rate access
1991	Ebone established in Europe
1990	HTML language for WWW
1987	JANET links with USA
1984	Est. one thousand users
1983	ARPANET, CSNET swap mail
1982	EUnet opens in Europe
1981	BITNET, CSNET open in USA
1980	JANET launched in UK
1979	CompuServe opens in USA
1973	UK & Norway connect to USA
1972	ARPANET exhibited in USA
1969	1st ARPANET host installed
1968	ARPANET proposed

Fig. 3. Plotting the growth of the Internet.

to a remotely-located computer, and it allowed data files to be transferred between two sites, as well as sending messages or "electronic mail" (E-mail) from one user to another. These functions (e.g. Telnet and File Transfer Protocol – FTP) are still used today very much as a matter of routine.

The early ARPANET worked on a simple "user/server" model, whereby one computer site (the user or "client") would log onto and interrogate another computer site (the server or "host"). This basis was to prove unsatisfactory and a new technique quickly evolved instead ("host-to-host" protocol) whereby the computer systems communicated more on equal terms. This newer method was incorporated into the first real networking command structure called Network Control Program, or NCP.

Open for Business

By 1970, ARPANET was on-stream and in 1972 made its first public appearance in the USA. The network had by now reached out to some 40 research sites in the USA, with each site sharing information and data files and also starting to send E-mail messages between individuals at the supercomputer sites. Thereafter, sites added to the system so that by the mid 1970s there were over one hundred host sites, all using a variety of commercial computer systems.

In 1973, according to Vint Cerf, then an Assistant Professor in Computer Science at SRI, ARPA proposed the idea of intermetting – "between nets," inter-linking not just individual computers, but entire networks. This saw the evolution of the Internet proper, with the objective of transmitting packets between computer networks of any flavour. It is true to say that this would be the vanguard of

the present-day Internet – a network of computer network systems communicating through "backbones" – major electronic carriers of electronic data.

It was increasingly apparent that the NCP protocol would not be able to cope with a projected increase in the number of host sites. In anticipation of an upsurge in the number of host systems requiring a connection to the network, in the mid 1970s a new communications structure called TCP/IP (Transmission Control Protocol/ Internet Protocol) was developed and adopted by ARPANET in 1983 as the standard protocol, and is still with us today.

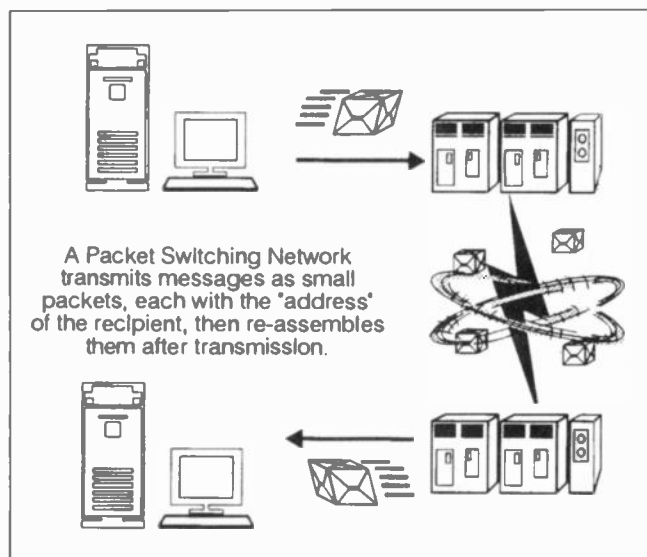


Fig. 2. How the packet switch operates.

Thus ARPANET continued to grow, adding 60 or so new hosts by 1977, and gaining its first international links in 1973 to Europe. Other computer networks sprang up in the USA, too. One system called the Unix User Network or "Usenet" was established at the end of the 1970s and was an open system whereby users could broadcast or exchange views electronically amongst other users subscribing to the same "newsgroup". Usenet – often called "news," though not a reference to news bulletins or current events in the conventional sense – is alive and kicking today.

"Anything and everything is available on The Net"

In the early 1980s, the National Science Foundation's CSNET became operational – the Computer Science Network mail service conceived for research groups at industrial and academic sites not connected to ARPANET. Even at that time, it had become clear that access via ARPANET was advantageous – unfairly so, if you couldn't access it – and demands for alternative networks were rising. CSNET was designed to be operated via modems (modulator-demodulators) enabling communications via ordinary telephone lines on demand.

Some twenty countries were connected in CSNET's heyday. However, connectivity and compatibility of CSNET with ARPANET was pencilled into the plan right from the start, as demonstrated in 1983 when the two networks started exchanging E-mail.

Now is the Time

IBM's BITNET (the "Because It's Time Network"), which served educational users, sprang up too, in 1981. BITNET was a "Store-and-Forward" system operated for the benefit of those populating the higher echelons of education. Users of BITNET could send E-mail and also subscribe to a computerised "mailing list" relevant to their particular interests which enabled a broadcasting of information amongst whole groups of specific users.

This was the electronic equivalent of somebody doing a mail-shot to interested parties, receiving subsequent feedback, and other users then broadcasting their response, all by E-mail. However, unlike ARPANET, users of BITNET did not have a direct connection to others but had to send messages via expensive leased lines for storage on a central server. These were then forwarded to the intended recipients or mailing-list subscribers. Both CSNET and BITNET combined to form CREN (the Corporation for Research and Educational Networking) in 1987 and CSNET was officially made redundant by CREN in 1991.

By the mid 1980s these American networking systems were starting to groan under the strain and the US National Science Foundation (NSF) decided to turn up the heat again using the latest technology, together with some heavyweight investment, to create a more effective network in the form of NSFNET. One source suggests that few of the costly NSFNET supercomputer centres were very efficient in practice.

The mushrooming volumes of computer "traffic" finally spelt the end of ARPANET itself in 1989/1990, having now outlived its usefulness and being engulfed by NSFNET. So, the world's first computer network which had laid the foundation stones for today's internetting system, dissolved without trace. The world didn't notice the disappearance of ARPANET, however, since the inherent self-healing nature of the network meant that packet traffic was simply routed by other means. NSFNET was, however, to become a critical backbone of electronic traffic in the USA, having had a major upgrade completed in 1992.

European Growth

Not wanting to be left behind, things had been happening in Europe, too: for instance in the United Kingdom, 1980 had seen the commencement of JANET: the Joint Academic Network which interconnected roughly 50 major UK academic sites. JANET tapped into NSFNET in 1987 via a transatlantic link.

EUNET was established in 1982 centred in the Netherlands and was the first European provider of services for commercial, rather than academic, users. It now covers the whole of Europe together with Central and Eastern European countries. Other European networks followed, including Ebone, established in 1991 and connecting 27 European countries, and having several links with the US.

The genesis of European networks becomes breathtaking and overwhelming, in a journey littered with acronyms. EARN started life as the European Academic and Research Network having some 40 member countries, to serve non-commercial interests only, including the European Space Agency and other high-level

sites. According to their brochure, EARN became the first general purpose computer network dedicated to universities and research centres throughout Europe, the Middle East and Africa. EARN linked into EUNET, JANET in the United Kingdom and several other systems.

More acronyms: TERENA – the Trans-European Research and Education Networking Association – formed in October 1994 as an amalgam of EARN and RARE (*Réseaux Associés pour la Recherche Européenne*) the latter having been funded partly by the European Union with a view to influencing and co-ordinating the efforts of European networking in the research sectors.

NORDUnet was founded in the early 1980s to serve educational and research sites only, within the Nordic countries of Denmark, Finland, Iceland, Norway and Sweden. It is very much alive and kicking today with connections to US and other European backbones, and, since many of its member shareholders' countries border on Russia, NORDUnet is said to be building a direct access through St. Petersburg to Russian networks, using satellite links. Neighbouring Scandinavian countries using the NORDUnet network seem pretty keen to establish further links on a scientific/academic basis with their opposite numbers in the former Soviet Union.

Writer's Bloc

Yes, even Russia and the former Soviet bloc countries are keen to become connected and they have their own series of computer communications networks. BALTNET covers the Baltic states. Also, Moscow has its own backbone connection and several networks are open, including MSUNET and SovAM. And, naturally, Australia and those "down under" are connected too.

Meantime, DANTE – short for the Delivery of Advanced Network Technology to Europe – was created as a non-profit-making firm in July 1993 to link together European national research and University networks via its EuropaNET backbone. It also helps out certain lower-capacity European networks by providing their US links. DANTE was recently strengthened, thanks to the involvement of British Telecom which now provides the Western European backbone for the DANTE R&D network.

So to return to the opening paragraph, yes, everybody is at it. Virtually every country in the world has its own computer communications network system, and all of these systems are networked together to form the Internet. The Internet is still an incredibly fluid medium, demand-driven, ownerless and self-regulating. Often it doesn't cope too well with the spiralling demands placed on it by users, and it is constantly being re-inforced, re-built and re-routed.

"There's a jawdropping upside to having on-line access..."

The world has shrunk immeasurably within the last twenty-five years. With the advent of the next development – the "World Wide Web" – now anybody, anywhere in the world can exchange information complete with graphics, sound, moving pictures, and 3-dimensional graphics, in a completely revolutionary way. We'll look at the World Wide Web (WWW) shortly, but let's now catch our breath and take a look at the present state of the art in the United Kingdom.

Dial I for Internet

Most Internet users like myself have a "dial in" connection to the service network. Internet Service Providers (ISPs) – Demon Internet Services in London claim to be the largest – provide local "Points of Presence" through which access may be gained to the Internet. The key, critical word is "local". All that is required is a suitable computer, preferably an IBM-compatible PC or Apple Macintosh, but Amigas and Acorns may also be used, a domestic phone line, a modem, and some Internet access software. (Even Windows 3.1 "Terminal" will get you off the ground, but it's far from ideal.)

The fact that local access is now generally available (but not universally so) means that the cost of telephone calls need no longer be prohibitively expensive. You only pay when you are connected to the Internet. You can exchange dozens of E-mail messages in a matter of minutes!

Looking at VAT-inclusive costs of a *local* phone call, British Telecom charge about one penny per minute using the telephone at off-peak times during the weekend, and 1.645 pence per minute during evenings and nighttime in the week. Peak time, daytime costs are 3.9 pence per minute, or nearly 10 pence a minute if you have to dial nationally (over 35 miles) during the working

day. Also recall that BT was the world's first national telephone company to charge actual time used per second. The minimum cost of any call, though, is about five pence.

A whole hour of "surfing the Internet" may be had for as little as 60 pence plus a modest monthly subscription. Discount packages are also available which reduce the cost by a further 20 per cent. A particularly ironic fact is that normal "off peak" times (after 6 p.m.) on the telephone network actually result in very many more users coming on-line to benefit from the off-peak prices. There's therefore a bit of a rush during the evenings when "off peak" prices produce peak levels of demand! It can therefore take several attempts to gain access, and connections can sometimes be slow due to the heavy traffic – especially if transatlantic links are involved. However, the situation has improved immeasurably over the past year as more Internet Service Providers have opened for trade, and more Points of Presence, and more lines, have gradually been added.

How a dial-in access works, using my own North Lincolnshire home as an example, is illustrated in Fig. 4. Choosing an ISP is rather like buying a mobile phone. Vodafone, Cellnet or Orange? And what is the reception like in your locality? Whilst Demon, Pipex and many other UK communications companies (over 130 ISPs at the moment) provide dial-in connections as well as managing permanent ones for large accounts, one or two others are more correctly called *On-Line Service Providers* (OSPs).

At Your Service

The two best known OSPs, and intense rivals, are America's CompuServe Information Systems (CIS) and America On-Line (AOL), both very active in the UK. These provide a breathtaking array of informative on-line services such as news, weather, share prices, and special topical "help" areas.

OSPs work in rather a different way. Both CIS and AOL are *closed* networks offering many "internal" services to subscribers, together with a gateway to the outside world and the Internet. They are rather more "squeaky-clean", priding themselves on being good "internet citizens". The rest of the Internet world is a bit more rough-and-tumble, at times. OSPs are ideal for family use, but they are arguably not the most powerful, cheapest or versatile way of accessing the Internet. Demonstration packs and free-access samplers are the best way to find out.

Additionally, service providers charge a modest subscription fee. Demon currently charge £11.75 per month which is a flat rate fee giving you unlimited access to the Internet. Certain systems, such as CompuServe, charge a further hourly fee after a basic month's allowance has been used. The minimum you will pay is about £6.65 per month.

So what's available on the Internet? There's a staggering array of things to see and places to visit. Like browsing through a library, not everything is of a high quality, some of it is a waste of time, not all of it will be to everyone's tastes, and some of it is not at all suitable for younger people. Remember, anything goes in "cyberspace", it's uncensored (but parental control software is available), and it's only a local call away.

Not only can you send electronic mail at a fraction of the cost of ordinary "snail mail" (letter post), but a bottomless mine of information is suddenly at your fingertips. Anything and everything is available on the Internet. In particular, the World Wide Web coupled with "search engines" – methods of searching the globe's Internet sites for a particular topic – offer the potential to unearth

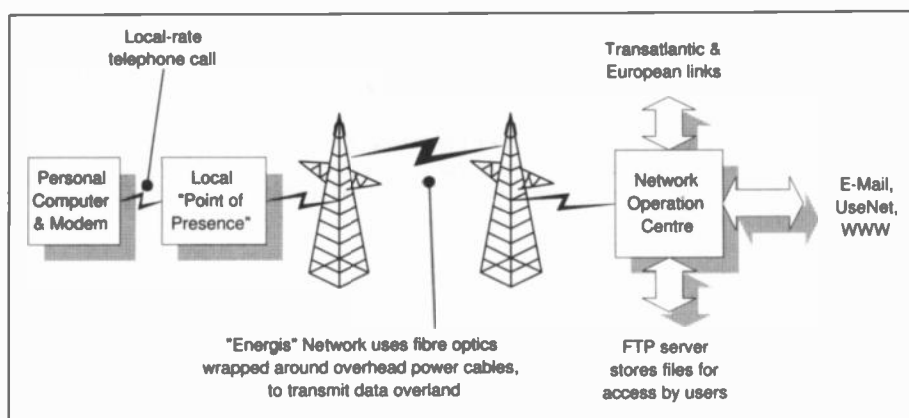


Fig. 4. Block schematic diagram showing how the "dial-in" access works.

unparalleled quantities of data from around the planet, right onto your desktop computer.

However, it's worth asking yourself, what are you going to do with all this information? Can you live without it? After all, you probably *have* so far! You can quickly find yourself completely overwhelmed with facts, figures, mail, data, graphics and bits of software... in fact, an absolute tidal wave of on-line information, which I guarantee can far outstrip anyone's capacity to either absorb it or stay abreast of it.

There's a jawdropping upside to having on-line access. Usenet, for example, is a way of openly discussing thorny questions with like-minded people who may reside anywhere on the planet (assuming you get an answer). If you are struggling with Windows '95 – or you need the latest video drivers for your monitor, say – then the Internet offers tantalising access to the information and the files you need, delivered via the Usenet, or World Wide Web or FTP sites.

Software bug need fixing? There may be a solution – or at least a reason – available from the American manufacturer's Internet site. Want to see the latest pictures from the Hubble telescope? They're available by internet, directly from NASA. Interested in a particular new product – like a car tyre or wallpaper paste? Or self-assessment of income tax? Browse a brochure, on-line... the list is endless.

You might alternatively simply use Internet access for specific research purposes or for handling E-mail, as well as for a little general interest or "net surfing". In short, the Internet is as big as you want it to be – and the cost need not be very high at all, if used sensibly and with discipline (an enormous amount, at times!). One thing is for certain, the Internet is here to stay and there's no ignoring it.



Screen shot of product information from Intel.

Now the downside: Internet access can occasionally be *mad-deningly* frustrating to work with. Peak-time usage around the globe can sometimes slow the so-called "superhighway" to something seemingly no faster than a cart-track! Successfully-made connections to other sites can slow down to a grind: sometimes you can download 90 per cent of the desirable data in no time at all (well, in a minute or two), and then you're left kicking your heels waiting for the final 10 per cent. Eventually you abandon that site and go look elsewhere. Don't expect a 100 per cent reliable service 100 per cent of the time.

Some of the material available online is of low quality anyway, which ultimately wastes your time and money. Expect to pay a small overhead for poor connections or wasted time – a lot more, if you don't have that all-critical local-rate access. Peoples' expectations of the Internet seem to mirror those of the telephone service – these days, rarely do you get a bad phone line or a break in service. Considering the technology behind it, sometimes a morse-key seems a mighty improvement over a humble dial-in Internet access account! The situation is improving all the time, but this is unfortunately partly compensated by a proportional increase in traffic. Now let's look at what "being wired" really means in practice. What do you get for your money?

E-mail

Electronic mail (E-mail) is used by virtually everybody with Internet access, for sending messages to other users. The main point of note is that delivery isn't instantaneous, and sometimes (rarely) mail may get lost. E-mail may only be "delivered" when the recipient dials-in to the Internet from their end, and collects it. It may also take a short time to be transmitted by the packet switching networks, to the ISP at the other end. This can be minutes or hours, or even longer.

Millions of these messages flow around the world every day. But even if the recipient is in Australia (which some of my readers indeed are), it can still only be a local phone call away. I receive E-mail from readers in many countries. It isn't generally



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Example WWW graphics of "what's new" from Tektronix.

:)	Smiley ("Don't take this seriously")
:(	Unhappy
;-)	Wink (make a joke)
:^)	Jokingly, nose out of joint
:-P	Sticking tongue out!
8-)	Smiley wearing glasses
:-0	Shock
BTW	By the way
FWIW	For what it's worth
FYI	For your information
HTH	Hope this helps
IMHO	In my humble/honest opinion
OTOH	On the other hand
ROFL	Rolls on floor laughing
RTFM	Read the (ahem!) Manual
<g> or	
<grin>	writer grinning
word	for stressing a word
word	for underlining

Fig. 5. Some common "Smileys" or emoticons used on Internet.

necessary to write a polished letter, since it's accepted that timely communications are more important than producing a beautifully penned message.

Sending an E-mail is rather like sending an open postcard. A message may pass through several systems in transit. In theory, confidentiality is not guaranteed. E-mail is not recommended for sending confidential information such as a credit card number, though I have yet to hear of anyone suffering as a result of doing so.

You don't need to be Shakespeare to pen an E-mail message but you *are* judged by exactly what you write. The recipient cannot hear the tone of your voice or see the twinkle of your eyes. It is embarrassingly easy to write something which is misinterpreted by the reader, especially if you have a dry, warped sense of humour like mine! (Such as the time that I joked on Usenet that you can receive satellite TV by gluing a steel coat hanger on top of the TV: an Internet user from Singapore wondered what on earth I was talking about! No sense of humour, some people.)

You'll often see strange punctuation used in E-mail messages (and Usenet, see later) to accentuate your feelings. The most common are shown in Fig. 5, along with some common abbreviations. They're called *emoticons* or *smileys*. No matter how bizarre or silly you think they are, smileys are a critical part of Internet communications, though I wouldn't use them in formal messages (to my publisher, say). To read, just turn the page through 90 degrees!

File Transfer Protocol

File Transfer Protocol (FTP) is a simple means of transferring files between two computers, in either direction. It is very common indeed to FTP files from another machine and download it over an Internet link, onto your own machine. Files could include software upgrades or fixes, information files, text files, graphics, or even software applications themselves.

It is possible, for example, to download by FTP a demonstration version of Turnpike, the Internet access software which I reviewed in *Innovations* (News pages), *EPE* April 1996. Every month, I FTP my material, text, graphics and all, down to the typesetting bureau at *EPE*. Floppy disks never change hands.

Telnet

Telnet is used as a way of logging in to a remote computer, always assuming you have been granted the right "permissions." You could be sat at your PC in Peterborough, and Telnet over (at a local phone call rate) to a machine in Pittsburgh, USA. For all it knows, the American computer thinks you're somebody using that computer system whilst sat in the computer room next door.

Telnet is used for interrogating machines, and for moving files around on that machine. A brief knowledge of the Unix language is often required.

Usenet Newsgroups

Now things start to get more interesting. Usenet is essentially a collection of global topical conference rooms. (Be aware, that the term "Conference" is used in a slightly different context by CompuServe.) Each conference room is actually called a "newsgroup".

Folks who are interested in a particular topic, "subscribe" to that newsgroup – or rather, they let their software do the hard work. There are now some 15,000 newsgroups, some of them in foreign languages but mostly English (American)-speaking. There are some United Kingdom groups, including: *uk.adverts.computer* and *uk.d-i-y*, or how about *uk.education.misc*? Or try *rec.food.cooking*? It's all there, covering recreation, leisure, science, computing, and more.

Usenet subscribers may post new "threads" to the newsgroup, which are read and "followed up" by any number of subscribers anywhere in the world. Like E-mail, you will only receive follow-ups and threads when you dial-in to the Internet. The reading and composing is performed off-line, to save the phone bill.

It is also possible to follow-up by sending an E-mail to those who have posted into the newsgroup. An excellent example was a recent request of mine in *sci.electronics.components* to track down a particular i.c. on behalf of a reader. Within eight hours, I had several replies from the USA followed by an E-mailed response from National Semiconductor themselves. The reader probably never appreciated the global effort which we undertook to find the chip.

The newsgroups I tend to handle are the *sci.electronics.** which are broadly American, but where I'm a regular contributor. Indeed, I have made many "on-line" friends through Usenet, some of whom E-mail me, others I have since met in the flesh. There is a whole protocol of manners and procedures called "netiquette" which, if followed by subscribers, will result in many happy hours burning the midnight oil. Some regulars can get upset if the wrong type of "off-topic" question is posted into a newsgroup, and steps are taken to ensure that everyone keeps in line.

By the way, concerned parents may need to be aware that there are some notorious "adult" newsgroups too, with names to match, which are used for posting pictures as encoded binary data: they would still have to be decoded after receipt, and would need special software to view, so there is certainly no danger of inappropriate pictures popping up on screen.

A small number of newsgroups are in fact "moderated" so that all posts are filtered by an appointed moderator. Posts which are deemed inappropriate for the "charter" of that group, are simply "killed" by the moderator.

Sadly, errant newcomers or "newbies" may sometimes be treated with little mercy by the regulars. The only sure way to avoid "flames" (abusive messages with varying levels of "temperature") is to read the newsgroup for several weeks to see what gives. You can expect to see swearing, at times. It is vital that you realise that everyone has exactly the same rights as everyone else, on Usenet.

One of the prime methods of stopping newbies from clogging the system with irritating questions is the requirement for them to read the FAQ ("Frequently Asked Questions") pertaining to that newsgroup or topic. This is often available from somewhere by FTP, and people are generally happy to say where it's available from. Some groups post a FAQ automatically every week.

I would say that the UK newsgroups (e.g. the *Demon* newsgroups) can be pretty rough at times. Internet is still relatively young in the UK and some posters do seem to treat it as a new toy: each newsgroup has its own level. Usenet is an amazing example of a self-regulating and anarchic world in action. I will be covering it extensively in future issues. I guarantee, it will only be a short time before you dip into the newsgroups, follow up to a posting, and then start a thread all of your own. Hermit-dom (and possible divorce) awaits you!

World Wide Web

Most of you have heard about it, many of you have seen it – even if only on TV. The World Wide Web (WWW) is a method of displaying information in a graphically-presented and appealing way. World Wide Web pages are, in essence, personal "brochures" or fact files deposited on a "web server" computer,

Next Steps - Getting Wired

If you're now keen to get "wired", firstly ensure you have a computer equipped with a suitable 14.4K or better still, a 28.8K modem (a fax-modem, with fax software, lets you send a fax directly from your word processor, as a bonus). Then contact a suitable Internet Service Provider to open a "dial-up Internet access account". Here are just a few:

BT Internet, Tel. 0800 800 150 (Residential) or 0800 800 152 (Business). Windows software, with Mac to follow.

CompuServe Information Systems, Tel 0800 289378. Offers Windows, Mac, OS/2 or DOS software. Free 1Mb Web space.

Demon Internet Services, Tel. 0181 371 1234. Offers KA9Q for DOS or "Turnpike" Windows (with Netscape Navigator 1.22) at a concessionary price. Free WWW space promised by August.

There are many more such providers and a glance through a specialist Internet magazine will give you many more contacts. Sometimes, sample access software is available to give you a free trial. *Happy surfing!*

and permanently connected to the Internet for anyone to look at. It's estimated there are 22 million web pages with 11 million words. Hence the WWW is enormously popular, and will undoubtedly form the key to global information exchange in future years.

Originally created in 1989 by the European Particle Physics Laboratory (CERN) in Switzerland, the use of Hyper Text Markup Language (HTML) for creating web pages was very rapidly adopted world-wide as a way of creating information sites, and for distributing work on the Internet. It's an excellent medium for donating information to the planet's Internet population.

Web pages use a combination of text with "tags", very similar to the way the Locoscript language used by old Amstrad PCWs used to work. Using HTML, plain (ASCII) text is tagged to give it attributes – bold, heading, italics, bullets, and so on. Graphical images (.gif or .jpg files) are referenced with tags too, and downloaded separately. Forms can be included too, which the viewer fills in when on-line. (That's how I got a wall poster from DANTE EuropaNET, yesterday. It arrived this morning!)

The tags and text are downloaded onto your computer, using "browser" software. The Netscape and Mosaic browsers are the best known, and the latest version of Windows 95 include a browser (*Microsoft Internet Explorer*) too. The browser's job in life is to unscramble the text, tags and graphics and display the final results on your computer. It's usual for web page space to be rented on a server computer somewhere. Indeed, major ISPs now give their Internet customers some free web space to play with, as part of the service.

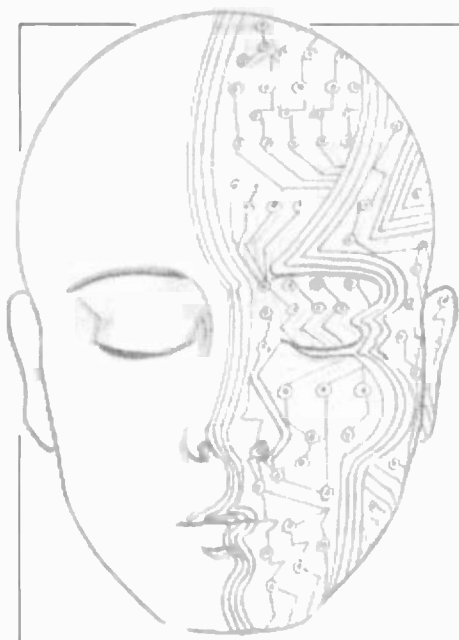
All major international corporations have their own web sites, and researchers such as myself are able to "search on the web" looking for data and information stashed away on web servers anywhere in the world. The most stunning part of it is that one web page may often refer you to another web page belonging to someone else. One mouse click and you're on your way to that site. In this way, you travel from one WWW page to another – but these sites could be absolutely anywhere in the world, and it is possible to circle the planet, in terms of actual mileage traversed, very many times per hour!

WWW pages start with a "Home Page" having a complex-looking "address" or URL (Uniform or Universal Resource Locator) which needs to be typed into the browser software when on-line. The software will then seek out this address, download the information and unwrap it before your very eyes. You could see the latest satellite pictures from NASA or read the Tap Dance Home Page! Everything imaginable is there.

There are now separate magazines available describing "what's hot" together with "what's cool". Surfing the net and checking out web sites are now hobbies in themselves. E-mail, FTP, and now the World Wide Web: that information superhighway has developed into "cyberspace", an intangible and inexhaustible electronic world of information viewed on your computer, and only a phone call away.

My new Internet column starts next month. *Net Work* is specially written for electronics enthusiasts and will help to pass on hints and tips for budding "internauts" everywhere. *Everyday Practical Electronics*, in association with the Department of Electronic Engineering, University of Hull, England will be opening its own World Wide Web page, and FTP site, in the near future. From here, you will be able to talk to us, download files associated with our projects, text files, Back Issue details, Subscription information and more! See you in cyberspace – soon.

● Alan Winstanley's WWW Home Page is:
http://fourworld.compuserve.com/homepages/alan_winstanley
E-mail: alan@epemag.demon.co.uk



Our regular round-up of readers' own circuits. We pay between £10 and £50 for all material published, depending on length and technical merit. We're looking for novel applications and circuit tips, not simply mechanical or electrical ideas. Ideas *must be the reader's own work and not have been submitted for publication elsewhere*. The circuits shown have NOT been proven by us. *Ingenuity Unlimited* is open to ALL abilities, but items for consideration in this column should preferably be typed or word-processed, with a brief circuit description showing all relevant component values. Please draw all circuit schematics as clearly as possible.

Send your circuit ideas to: Alan Winstanley, *Ingenuity Unlimited*, Wimborne Publishing Ltd., Allen House, East Borough, Wimborne, Dorset BH21 1PF. They could earn you some real cash!

Mosquito Repeller – buzz off!

JUST in time for summer holidays, this simple battery-operated Mosquito Repeller circuit will hopefully guarantee fewer mosquitoes in your house, and will run for one month non-stop on an ordinary PP3 battery.

The circuit shown in Fig. 1 produces approximately a 22kHz sound which repels *female* mosquitoes (the one which bites!). It uses a standard unijunction transistor relaxation oscillator based around TR1, coupled directly to a small amplifier TR2.

The circuit drives an audio output transformer T1 with a small 8 ohm loudspeaker as its load. When testing, substitute capacitor C1 for a 22nF type to enable an audible tone to be heard.

Andrew Duncan,
Rabat, Malta.

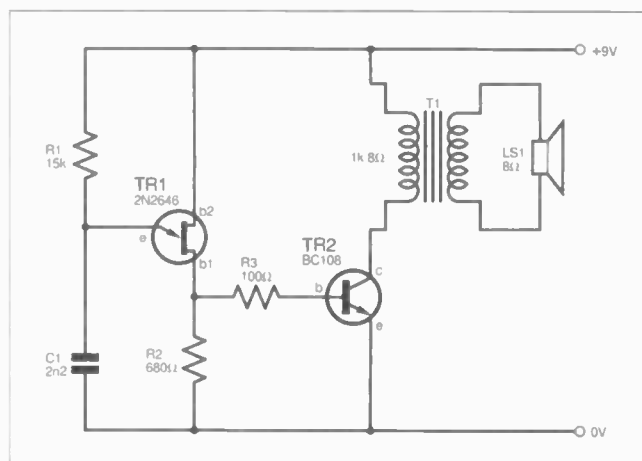


Fig. 1. Circuit diagram for a Mosquito Repeller.

Ni-Cad Discharger – for better batteries

THE experimental circuit of Fig. 2 will discharge a single PP3-size Ni-Cad battery to the safe recommended minimum of 7V – i.e. one volt per cell.

The circuit uses a low power op.amp IC1 as a comparator whose threshold level is set by VR1 (7V for PP3 types). The output from pin 6 illuminates D1 to indicate that discharging is in progress and will extinguish when the discharge is complete.

Resistor R3 is a "load resistor" whose value was chosen so that the discharge current is twice the nominal charge current of the Ni-Cad – 22mA for a PP3. The components could be altered to accommodate the discharge of battery packs in the range of 6V-18V.

S.M. Spencer,
Sleaford, Lincs.

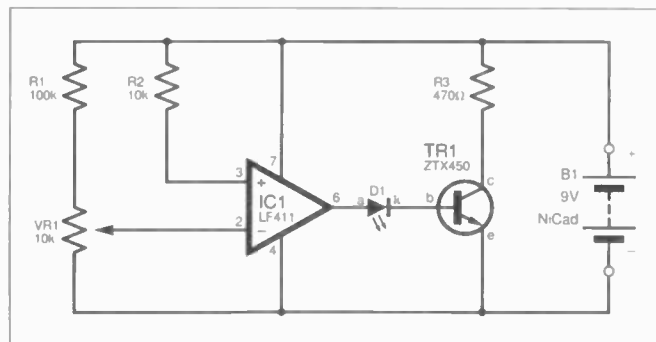


Fig. 2. NiCad Battery Discharger circuit.

Simple Amplifier – watt power!

A SIMPLE Power Amplifier capable of driving a loudspeaker directly, is shown in Fig. 3. It is a "sliding bias" emitter follower, having unity voltage gain and a high input impedance. To reduce power wastage and so increase efficiency, the transistor bias is proportional to the input signal amplitude. The bias is generated by D1 which clamps positive peaks to the positive supply rail.

Diode D1 is a germanium type and the circuit bias is adjusted by VR1 to minimise signal distortion whilst not dissipating excessive power. TR1 should be a pnp Darlington transistor (e.g. TIP127) or separate devices may be used.

The load may be a loudspeaker or a lamp and is simply wired in series with the power supply as shown.

W. Gray,
Farnborough, Hants.

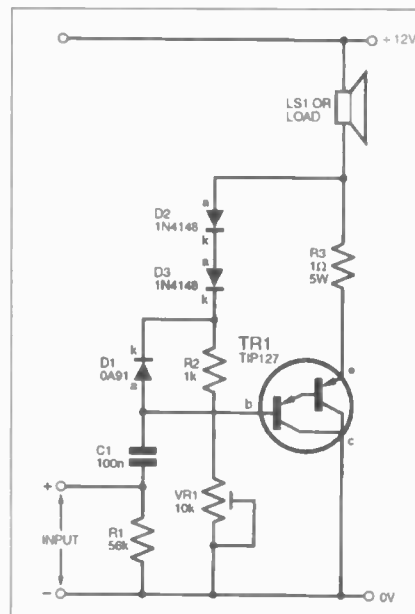


Fig. 3. Circuit diagram for the Simple Amplifier.

Computer Control of Digital Radios

THE circuit shown in Fig. 4 illustrates my solution to using a computer to control a digital radio receiver.

A simple method of interfacing the two would be to use some form of switch with an isolated control line. In my circuit, twelve switches can be opened or closed, using four TTL signals. Only one switch can be closed at any one time, this is equivalent to a single key press on the radio keypad.

Using a 4-line to 16-line decoder i.c. type 74154, IC1 outputs are inverted by IC2 and IC3 (7404 Hex inverters) so that one output is high and the other 15 are low at any one time. IC6 are 4066 quad analogue switches whose inputs are pulled up by twelve 4.7 kilohm resistors, as shown in Fig. 4.

This offers twelve control switch functions which requires, naturally, splicing into the radio set to access the keypad control lines. The benefit is that automated sequences can be used at preset intervals, or frequencies can be switched in accordance with a programme.

The actual connections to the inputs A-D are left to the reader. I used a second-hand HF radio and tested the circuit successfully on the parallel port of an old 64K CPC machine.

*D. Jackson,
Hawick,
Roxburghshire.*

Apology - Please Take Note

Much to our dismay, a small minority offend the spirit of this column by submitting material which is *not* of their own creation, or they make multiple entries to every magazine in the hope that it will be published several times over. Copyright infringement is now a serious matter which can result in legal action. We do our best to research and ensure that all circuits are genuine, and contributors are required to sign a legal release form concerning freedom from copyright restrictions. If you see any submissions which clearly aren't original, please contact us immediately. We will stop the payment, embarrass the miscreants to boot, and hold them legally responsible.

We apologise to Mr. Alan Williamson - the *real* designer of the *Remote Handset Tester* featured in the May 1996 issue of *Ingenuity Unlimited*. This circuit was originally published in *Electronics - The Maplin Magazine*, June 1991. The *Infra Red Headphone Transmitter/Receiver* (also May 1996) was again a copied circuit and we apologise to *Elektor*, the copyright owners. Our thanks to the several loyal readers who contacted us with this information. Please play fair and help to keep this grand old column alive. Without everybody's co-operation, there will sadly be one less opportunity to express your ingenuity.

Incandescent Lamp Flasher

IN RESPONSE to a challenge to flash a low-voltage bulb using only one transistor. I designed the simple Incandescent Lamp Flasher circuit of Fig. 5.

Feedback is produced by placing a light-dependent resistor (l.d.r.) resistors R1 adjacent to the lamp LP1. With values of resistors R2 and R3 as shown, the flash rate in practice was approximately 0.3Hz with ambient indoor lighting, though these values may be experimented with.

Resistor R3 was chosen so that the lamp draws approximately 60 per cent of its rated current (i.e. a dim glow), with the l.d.r. covered or unhooked. The transistor is a common 2N3055 which could be replaced with a power Darlington device, for example, to enable high power lamps (e.g. car headlamp bulbs) to be driven.

*Walter Gray,
Farnborough, Hants.*

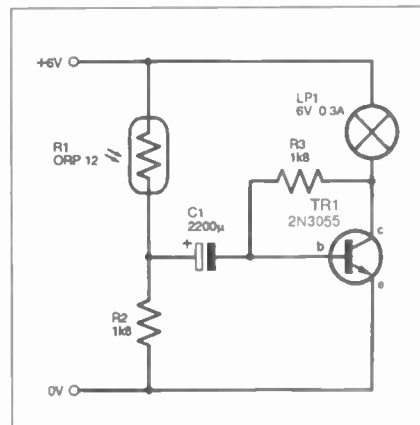


Fig. 5. Incandescent Lamp Flasher circuit diagram.

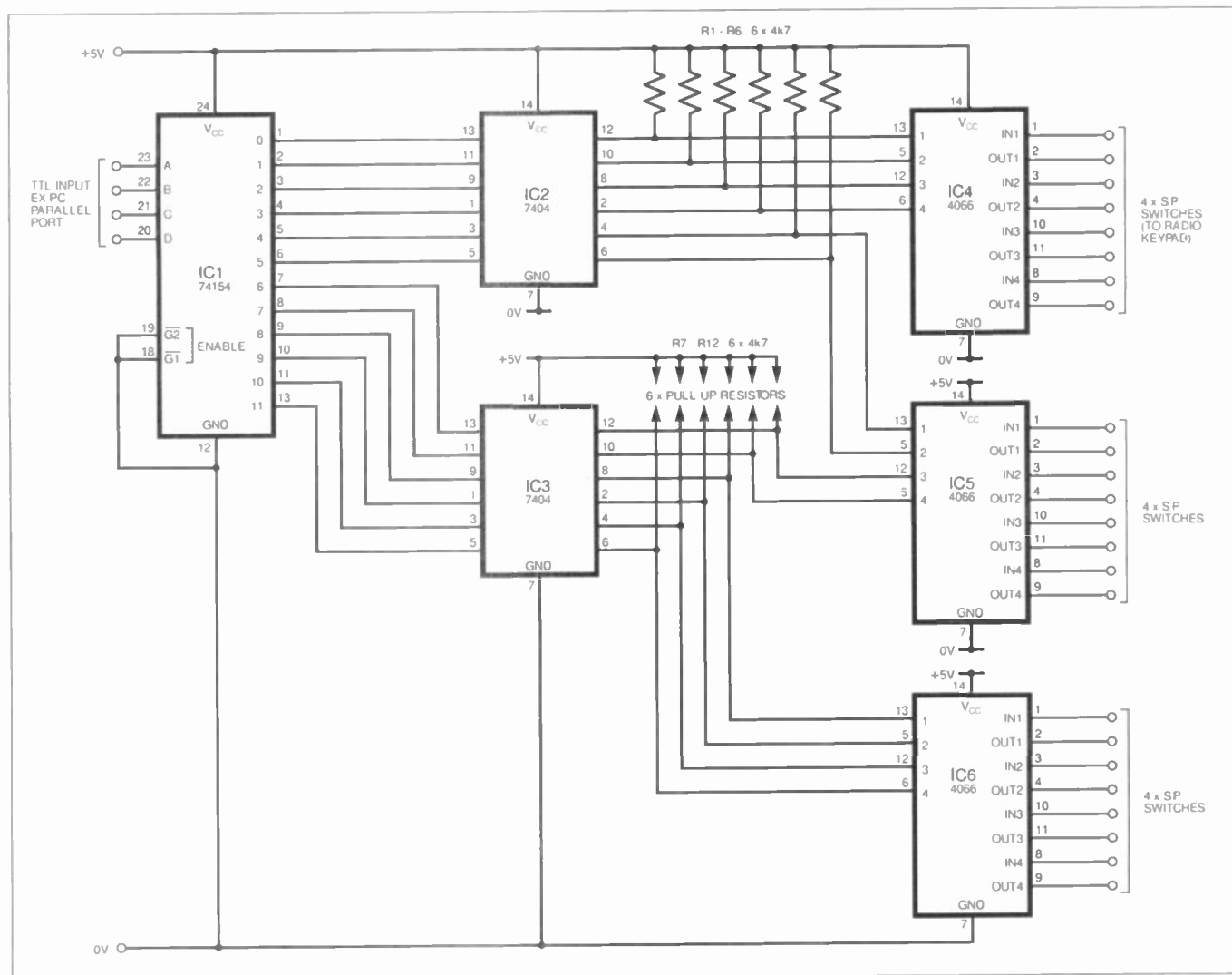


Fig. 4. Circuit diagram for a Computer/Digital Radio Interface.

New Technology Update

Ian Poole reports that new insulated gate bipolar transistors promise higher voltage and current ratings, and better production yields.

INSULATED gate bipolar transistors or i.g.b.t.s are replacing bipolar transistors in an increasing number of applications. They use less silicon for the same rating and require much lower drive powers.

As such, they are ideal devices to use in a number of power applications including motor controllers, lighting and even welders. In addition to this, they are used in a host of other fields closer to the more usual electronics applications.

Power MOSFETs can also be used in this type of application, but one of their major problems is their comparatively high "on" resistance. However, i.g.b.t.s offer a solution to this problem, giving improved conduction characteristics, whilst still retaining many of the appealing features of the MOSFET.

They are easy to drive as they are voltage driven devices whilst they have a high peak current capability, and a general ruggedness. Unfortunately, one problem with i.g.b.t.s is that their switching speed is inferior to that of a power f.e.t., making them less attractive in some applications.

Typically, an i.g.b.t. may have a fall time of around 200ns whereas a power MOSFET may be only 40ns. An equivalent bipolar transistor will possess a switching time very similar to the i.g.b.t.

Where the i.g.b.t. wins hands down over both bipolar transistors and power MOSFETs is in the current density for a given voltage drop. Power MOSFETs come in second, with bipolars a poor third.

Equivalent Circuit

An i.g.b.t. has a relatively complicated structure, and this is reflected in its equivalent circuit, which is shown in Fig. 1. Here an *n*-channel MOSFET drives an *npn* transistor and a junction f.e.t. This

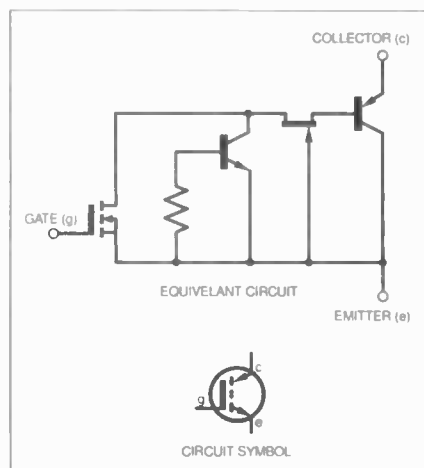


Fig. 1. Equivalent circuit and circuit symbol for an I.G.B.T.

configuration gives a high level of gain, being in the form of a pseudo Darlington. This gives sufficient drive for the high power output transistor.

A further advantage of this configuration is that the j.f.e.t. is made to take most of the voltage drop, allowing the MOSFET to be a low voltage type having a low $R_{DS(ON)}$. In turn these drive the output transistor.

Whilst the two bipolar transistors in the structure actually form a CSR (controlled silicon rectifier) and there is a possibility of latch-up, the resistor in the base of the drive transistor serves to eliminate this possibility.

The device has three terminals, a gate (g), collector (c) and emitter (e). The output terminals are something of a misnomer. The collector is connected to the emitter of the internal output transistor and the emitter to the collector as shown in the equivalent circuit. However, the external connections tend to represent those of another type of device was used.

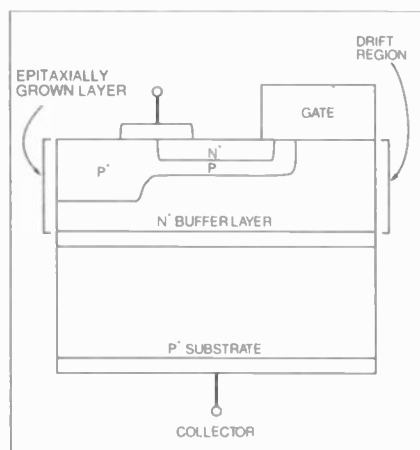


Fig. 2. I.G.B.T. structure.

Structure

The structure of the device shown in Fig. 2 very closely resembles that of a power MOSFET. Both devices possess a similar gate structure, *p* wells and source contacts. In both devices the *n*-type material under the *p* wells are sized to enable the device to accommodate the full voltage swing.

Despite the similarities of the two devices the operation of an i.g.b.t. is much closer to that of an ordinary bipolar transistor. This results from the *p+* substrate which introduces minority carriers into the *n*-region and resulting in carrier modulation and a low level of losses. By comparison, in a power MOSFET over 50 per cent of the losses occur in the *n*-region.

Developments

Most i.g.b.t.s are manufactured using standard bipolar techniques. This makes them more expensive, and does not enable their full potential to be realised. To overcome this problem much development work has been undertaken by Motorola to produce a more competitive device.

The conventional method for manufacturing i.g.b.t.s requires the growth of an epitaxial *n*-type layer or drift region about 100 microns thick onto the wafer, which is generally a 15mil. thick *p*-type semiconductor. In view of the thickness of the epitaxial layer it takes a long time to grow, making this type of epi-i.g.b.t. expensive. This thickness is vital to the operation of the device and is required to enable it to handle high voltages.

Another disadvantage of the process is that thickness of the layer increases the carrier lifetime and this reduces the speed of the device. Generally this is overcome by the diffusion of a heavy metal like gold into the device, although even with this process they cannot compete fully with power MOSFETs.

To reduce costs of i.g.b.t.s Motorola has introduced a new style of device. Called a "non-punchthrough" device it has a number of crucial changes. The first is that the drift region is made from the complete thickness of the wafer.

The second change has been implemented in the manufacturing process. Previous varieties of non-punchthrough device have been made before. However, the large wafers proved to be very brittle in the manufacturing process, and this resulted in very low yields. The process engineers have improved the process to eliminate manual handling, and generally simplify the manufacturing process. As a result defects have been reduced to acceptable levels.

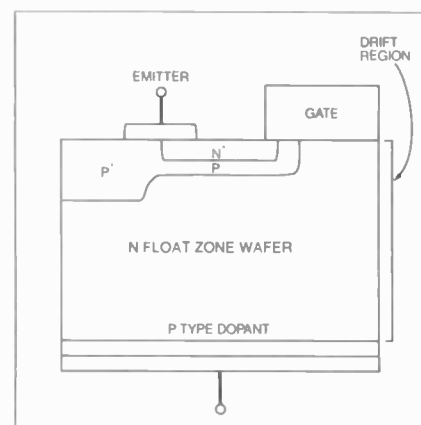


Fig. 3. Modified I.G.B.T. structure.

Results

Devices with impressive specifications have been manufactured using the new process. Ratings of up to 1200V and currents of up to 75A have been achieved. It is found that the new devices have lower energy losses than their epi-i.g.b.t. relations. A further advantage of the new devices is their temperature coefficient. This allows them to be run in parallel and

self-share the load without the need for complicated circuitry.

Whilst a number of the new devices are available, development is still progressing. New devices with higher voltages are planned. It is expected that before too long devices with voltage ratings of 1700V will be available.

One further advantage of the higher voltage devices is that they require larger drift regions to withstand the

increased voltages. In turn this leads to thicker wafers which are more resilient, which in turn will reduce the amount of wafer breakage and increase the overall yield.

Work is also being undertaken to improve the switching times. This is greatly governed by the doping level close to the collector. However, it is a trade off against other characteristics.

REPORT

by Barry Fox



Encarta - HOW ultimate?

Microsoft sold over 100,000 copies of *Encarta 96* over the Christmas period in the UK alone. Billed as the Ultimate Voyage of Discovery, it's the latest version of the multimedia CD-ROM encyclopaedia that Microsoft has been putting out every year for the last three years.

Encarta (cost £50 or less depending on special offer deals) has now been tailored for the UK market. It contains more entries with a local flavour, and less material that will appeal to the North American market.

Key in "Thatcher" and up comes a written biography of Margaret Hilda Thatcher, born Roberts, with a colour mug shot. The sound of her Falkland Islands crisis speech comes through the speakers. Some words in the text are highlighted in red. Use the mouse cursor to click on one of them, John Major, and up comes a similar biography with colour picture and a recording of the PM's speech on peace in Ireland.

Type in "Beatles" and up comes a biography of the pop group with a pointer to the word "Beatlemania". Click on it and a window in the screen displays a short sequence of movie footage complete with sound, showing the group arriving at an airport and being mobbed by the crowd.

Frankly no Saint

Browsing can be addictive, but never a complete source of information. Key in "Bruno" and you get Saint Bruno an 11th Century German monk, and Bruno Walter, the German-born conductor. But no Frank.

Encarta is part of Microsoft's "Home" series and as such it is more likely to work smoothly than most Windows CD-ROMs. As Microsoft's head man, Bill Gates, said recently at a seminar when asked about the near monopoly his company has won by selling PC operating systems and programs to go with them, "I guess our stuff does work better with our stuff".

ROMs like *Encarta* are aimed at the education market. They encourage children to use the content for school essays. Whereas kids previously had to search through paper books and then write down their own words, ROMs usually allow downloading of the raw text, for

editing and printout in a different context.

ROM, trick and - no 'Arry!

Because *Encarta* is more likely to run smoothly than a lot of other non-Microsoft ROMs, it is a safe bet that when a teacher now asks the class to write an essay on the Falklands or the Beatles, a lot of the work that comes in will look remarkably similar.

Smart teachers will now start checking *Encarta* before setting an essay. They could kick off by asking the class to examine the roll of Frank Bruno as a behaviour model for young black kids. That would quickly sort the genuine students from the short cut text downloaders.

The Blumlein Scandal

I appreciate the letters and calls I get from readers about the ongoing scandal of the Blumlein archives.

I can report that Alan Blumlein's son, Simon, is as anxious as we all are to ensure that the mass of original papers collected over decades by Francis Paul Thomson find a safe archive.

Although Mr Thomson is still active in writing curiously worded letters, and threatening legal actions, there is clearly no hope of his ever finishing the biography he has for so long now been promising to write.

One reader has passed on a copy of a letter from the Royal Society which is very useful in confirming what the IEE, the Institution of Electrical Engineers of which Mr Thomson is a member, has so far fudged.

"Mr Thomson agreed in 1992 to give us the Blumlein papers in his possession, but has not yet done so"

writes Mary Nixon, Head of Fellowship and Information Services at the Royal Society.

This offer to the RS followed an official complaint that I lodged with the IEE, asking the Institution to investigate Mr Thomson's use of IEE membership to corral biographical material. My information is that the IEE has now reopened this investigation, in the light of the Royal Society's failure to receive the promised material.

Jackdaw of Reams?

The wider moral of this unsavoury story is that under current laws if someone wants to bury the reputation of a dead genius, they can do so by jackdawing all available material and continuing to promise a biography until they themselves die. This, of course, raises the all-important question. What happens to that material when the jackdaw dies?

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Compact layout of components on the rear of the front panel. The oscillator board is held in position by the potentiometer mounting collars and nuts.

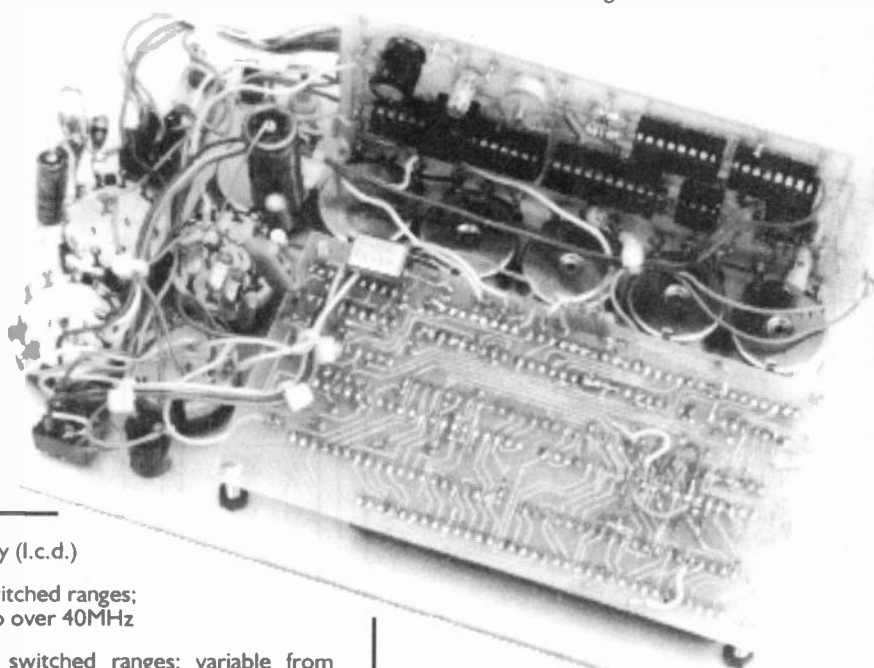
LAST month we dissected all the individual circuits that go to make up the Ultra-Fast Frequency Generator/Counter and examined their various operating functions. We conclude this month with circuit board construction, final assembly and testing.

CONSTRUCTION

Two printed circuit boards (p.c.b.s) are used in this design. Their topside component layout details, together with full size underside copper foil masters, are shown in Fig. 9 and Fig. 10. These boards are available as a pair from the *EPE PCB Service*, codes 994 (OSC.) and 995 (LCD Drivers).

Specification . . .

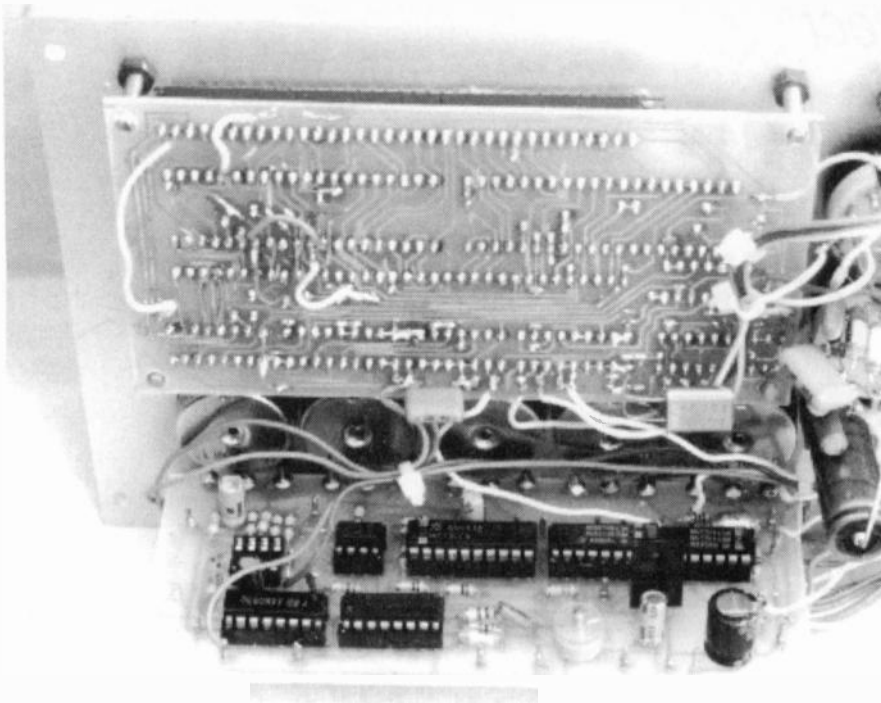
Display:	8-digit liquid crystal display (l.c.d.)
Oscillator-1:	Square wave output; 9 switched ranges; variable from 0.05Hz to over 40MHz
Oscillator-2:	Square wave output; 5 switched ranges; variable from 0.01Hz to 1.6MHz. Switched f/50 or f/100 square wave output. Switched f/50 or f/100 sinewave output. Sinewave amplitude variable from 0V to 2.5V peak max.
Oscillator-3:	10MHz fixed rate; crystal controlled square wave output
Oscillator-4:	32768Hz fixed rate; crystal controlled square wave output
Input 1:	Digital input; 0V to 5V logic; range to over 40MHz
Input 2:	Analogue input 2.5V peak-to-peak; range to over 400kHz; variable trigger level
Counter Reference Timing Options:	1Hz; 0.1Hz; external timer input logic 1, pulse length referenced to 10MHz; event counting
Power Supply:	7V to 12V d.c. from external source; 5V d.c. output



Start off construction by inserting all the on-board link wires, some of which end up underneath i.c.s. Next, insert all the i.c. sockets.

The socket for the l.c.d. consists of two 34-pin s.i.l. (single-in-line) sockets soldered into the p.c.b. In order to raise the display X1 above the level of IC7 and IC8 which it spans, another pair of 34-pin s.i.l. sockets is pushed into the first.

It is unlikely that 34-pin sockets can be obtained, so cut 40-pin lengths down to size, carefully, to avoid breaking off the 34th pins. Dual-in-line (d.i.l.) sockets could be cut to size instead of s.i.l.s, if preferred.



Early prototype showing component layout on the oscillator p.c.b. and the 10MHz reference crystal and one of the supply decoupling capacitors (C26) soldered to the track-side of the display board.

Other components can now be inserted and soldered in order of size. Insert terminal pins for all off-board connecting wires.

Five of the rotary potentiometers are mounted directly on their p.c.b. Either use p.c.b. mounting types, or solder normal panel mounting types to terminal pins on the board.

When board assembly is complete, and before wiring up the boards to the front panel, thoroughly check both boards for soldering perfection. Pay particular attention to the possibility of solder shorts between i.c. pins and the tracks that pass by in close proximity.

FRONT PANEL

The suggested plastic case has an aluminium sloping front panel to which both p.c.b.s, plus the sockets and remaining controls are mounted. Drilling details for the socket section of the panel are shown in Fig. 11. You can, if you wish, have an enlargement photocopy made of this drawing to life size (130%) and use it as a drilling template. It is a rear view of the panel, so secure it accordingly.

The l.c.d. viewing cut-out is made using the time-honoured technique of drilling small holes within its perimeter, chiselling

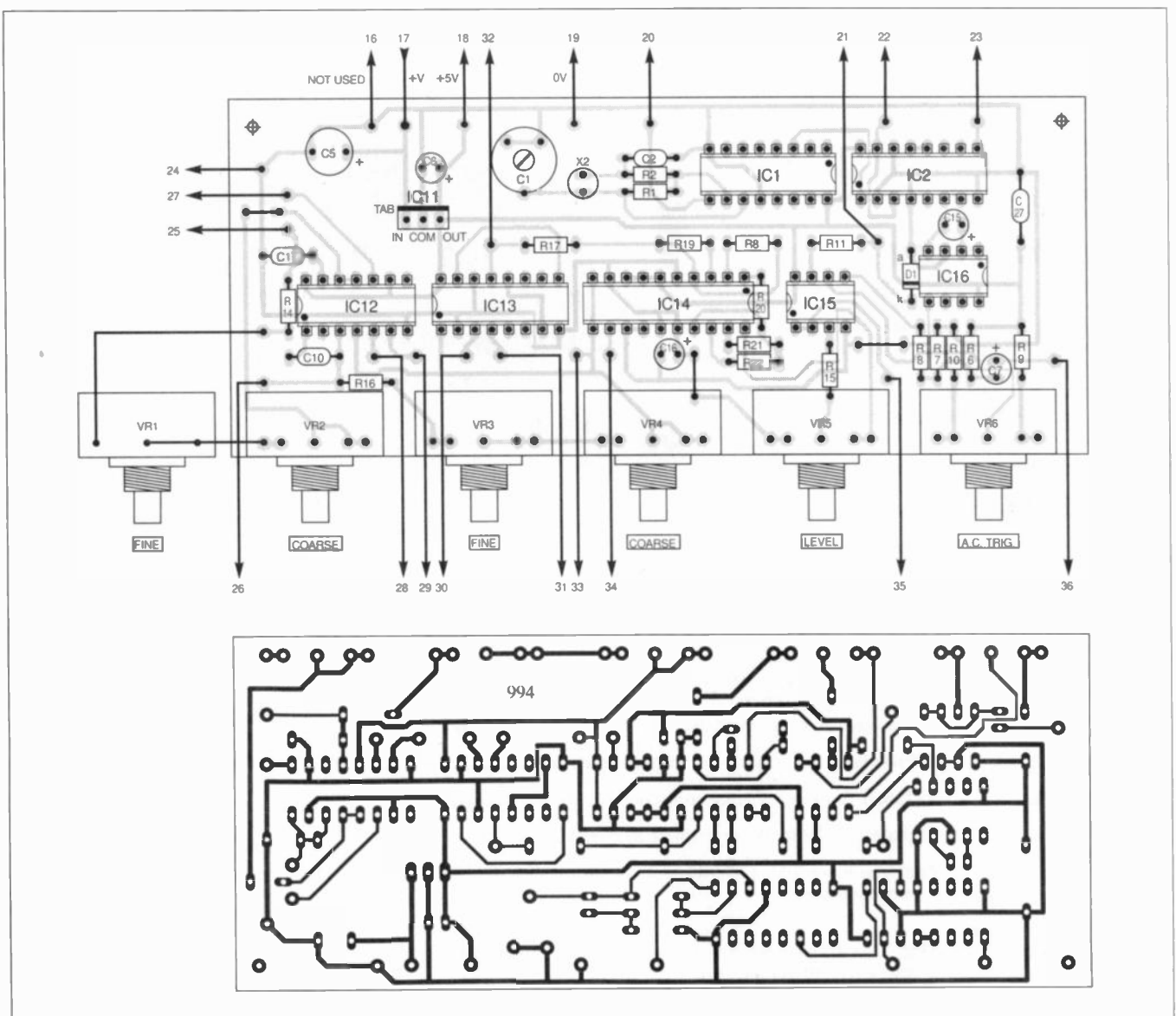


Fig. 9. Component layout and full size copper foil track master pattern for the main oscillator printed circuit board.

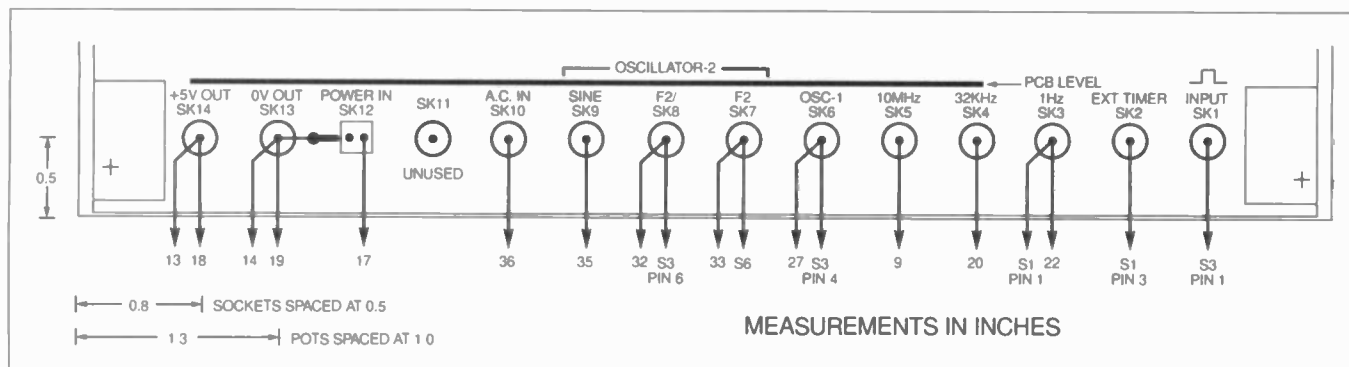


Fig. 11. Front panel drilling and socket wiring details. The potentiometer fixing hole centres are one-inch (25.4 mm) above the centre line for the sockets and spaced as indicated.

through the holes and then smoothing off with a file. The precise dimensions will depend on the exact l.c.d. used (although pinouts will be the same, slight overall size differences may exist).

Deburr all holes when panel drilling is complete.

With the prototype, a computer-generated printout of the control and socket

legends was stuck down on the front of the panel – see photographs. A ball-point pen was used to punch through the paper at each hole position.

The line of sockets should now be inserted and their nuts tightened down (carefully, so as not to tear the legend paper).

The l.c.d. board is mounted on the panel

using twelve nuts and four bolts. Three nuts are used with each bolt, one to fix the bolt to the panel, one to set the spacing, the third to secure the board against the spacer nut.

The Oscillator board is secured to the panel via the bushes of the five pots mounted on it, after which the remaining panel components can be mounted.

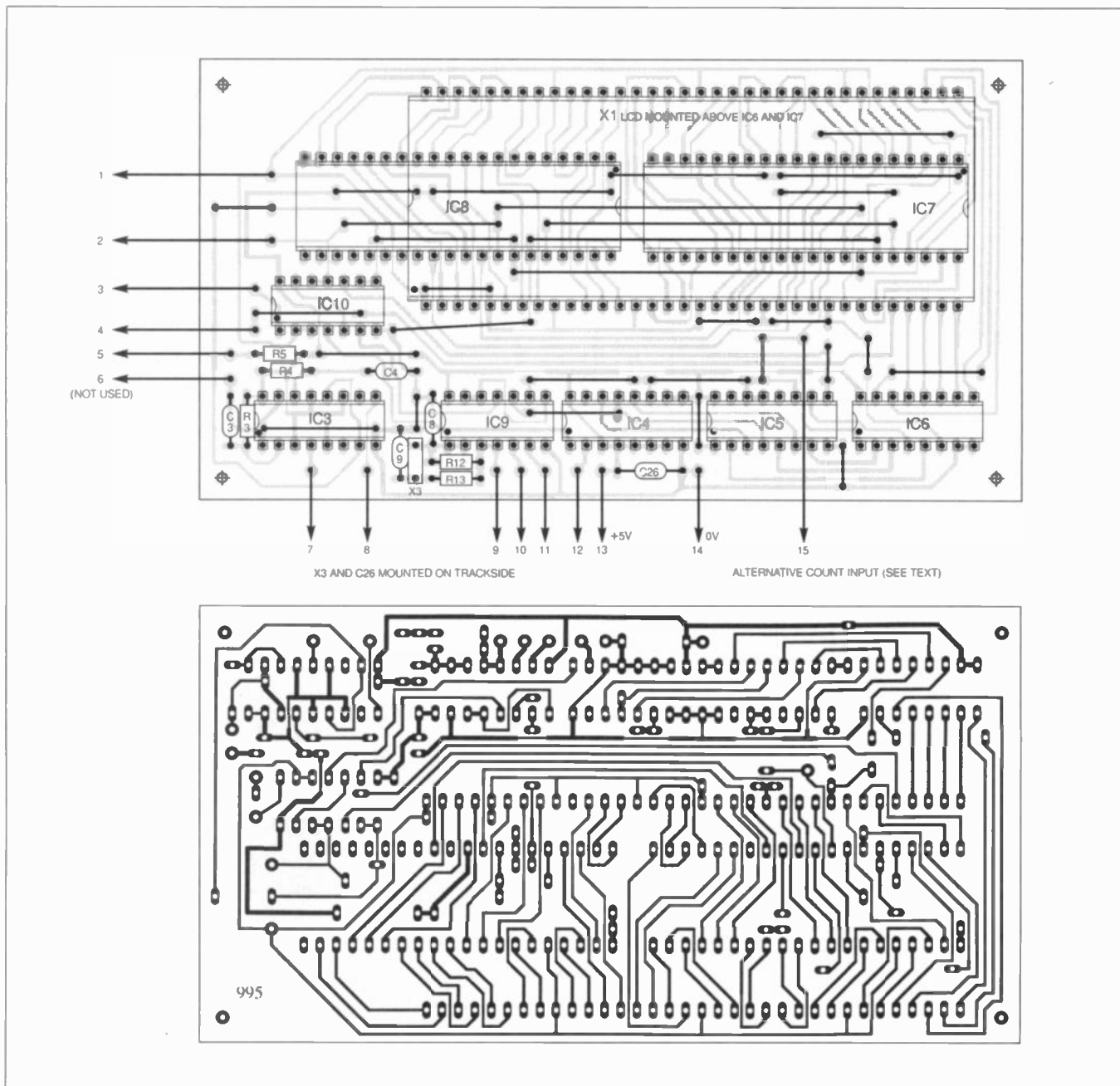
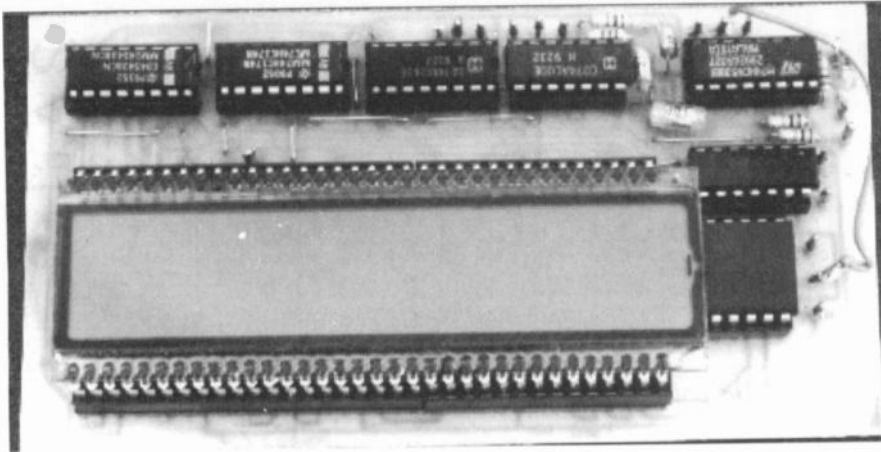


Fig. 10. Component layout and full size copper foil track master pattern for the l.c.d. driver printed circuit board.



Layout of components on the prototype Display board. The 8-digit l.c.d. module is mounted on a double-bank of 34-pin single-in-line sockets (piggy-back fashion) to raise it above the driver i.c.s.

Wire up the boards to the sockets as indicated in Fig. 11. Each numbered line in the drawing is connected to the same numbered terminal pin on one of the boards. Socket SK11 is a spare which may be used for any purpose that comes to mind. Note that the view in this drawing is from the rear of the panel.

Details of the wiring from the other components back to the boards are shown in Fig. 12, which also shows a rear view of the panel. Note that many capacitors are mounted directly onto the switch tags.

Keep all wiring as short as possible, using cable ties where appropriate. Preferably use colour-coded stranded wire. Double-check your wiring for accuracy.

Table 1: Socket Summary

SK1	Logic Input – 0V to 5V logic signals only
SK2	External Timer Input – 0V to 5V logic signals only
SK3	1Hz Output
SK4	32768Hz (32KHz) Output
SK5	10MHz Output
SK6	Oscillator-1 Output (F1)
SK7	Oscillator-2 Output (F2)
SK8	Oscillator-2 Divided by 50 or 100 output (F2/)
SK9	Oscillator-2 Sinewave Output, 0V to 2.5V pk-pk max.
SK10	Analogue Input, +/– 5V pk-pk maximum
SK11	Spare
SK12	Power Input, 0V and +7V to +12V d.c.
SK13	0V output/common connection
SK14	+5V output

Except for SK9, all frequency outputs are square waves, 0V to 5V pk-pk

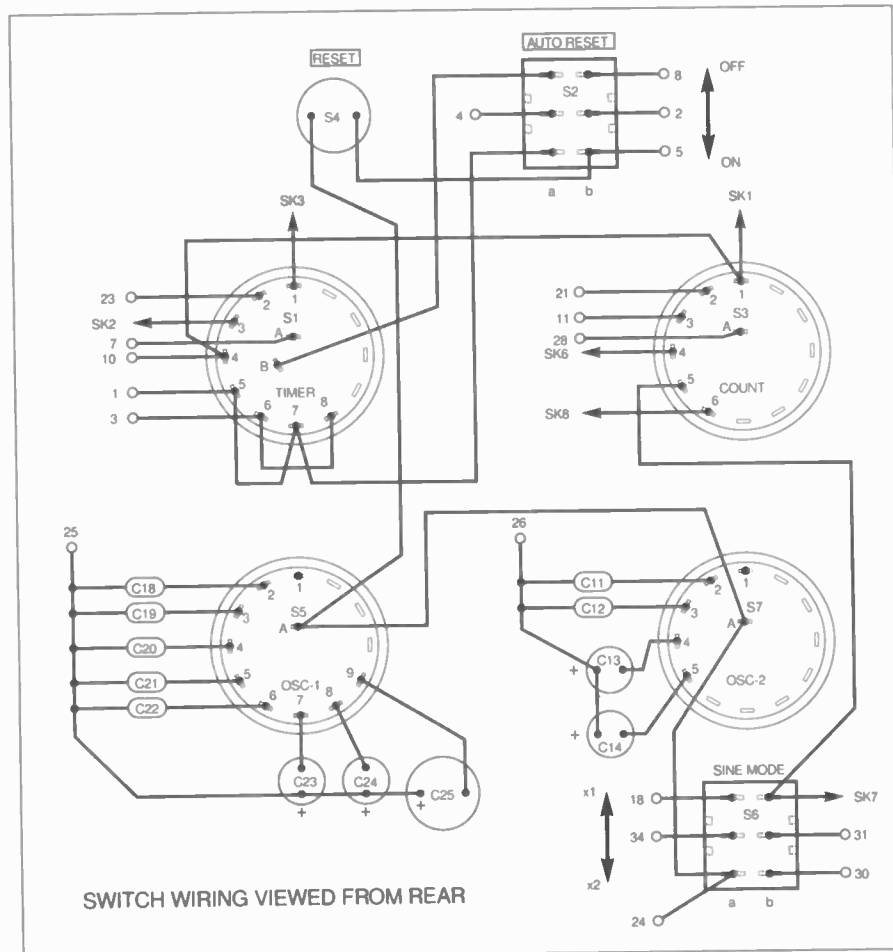


Fig. 12. Switch wiring details. The numbered leads go to identical points on the p.c.b.s.

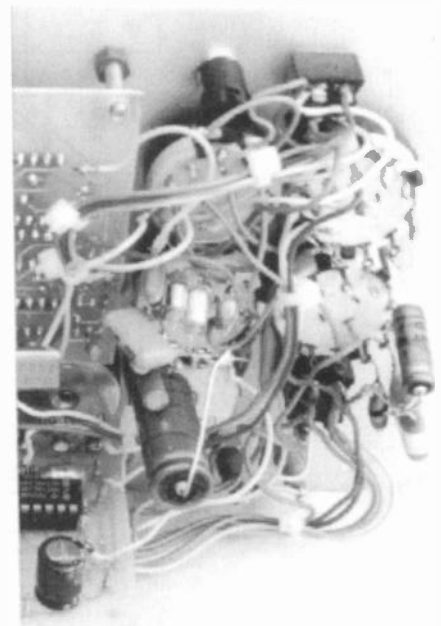
POWER UP

Although circuit board checking has already been done visually, carry out a short-circuit test *before* inserting the d.i.l. i.c.s. Connect a multimeter set to a low ohms range between 0V and the output of regulator IC11. Only a high impedance reading should result.

Plug the chosen power source into socket SK12. This may be any d.c. supply between 7V and 12V, preferably well-smoothed, though it does not need to be too well regulated. Switch on, and with the multimeter on a d.c. voltage range, confirm that the voltage on the output of IC11 is at 5V.

With power off again, insert the d.i.l. i.c.s, taking the usual anti-static precautions for all of them (briefly earthing yourself to a grounded item of equipment).

When powered up, again check the voltage output from IC11. Once satisfied, check every possible permutation of switched functions, input and output sources, observing the display where appropriate.



Mounting the oscillator capacitors directly on the rotary switches saves space, but does require careful soldering and some patience!

Switch S1 – Timer Source Select:

1. 1Hz sampling rate (normal frequency count setting)
2. 0.1Hz sampling rate
3. External timer source via SK2
4. Pulse measurement via SK1 (S3 to position 3)

Switch S2 – Reset Mode:

1. Automatic resetting On
2. Automatic resetting Off

(Manual mode – Event Counting)

Switch S3 – Count Source Select:

1. Logic input (0V to +5V)
2. Analogue (a.c.) input
3. Pulse length measurement (S1 to position 4)
4. Oscillator-1 (F1)
5. Oscillator-2 direct (F2)
6. Oscillator-2 divided by 50 or 100 as set by S6 (F2)

Switch S4 – Manual Reset:

1. Push to reset when S2 is set to Auto Off

Switch S5 – Oscillator-1 Range:

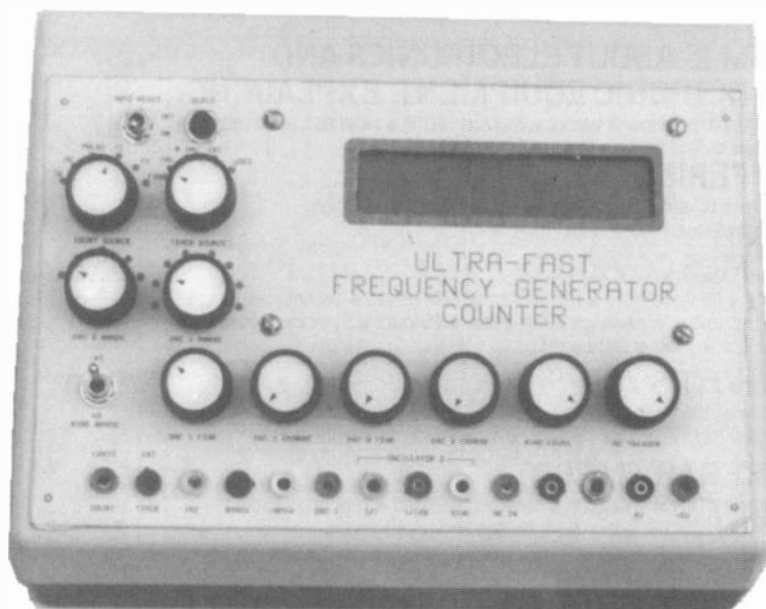
Nine positions – calibrate on test

Switch S6 – Filter Range Divider:

1. Oscillator-2 rate divided by 100
2. Oscillator-2 rate divided by 50

Switch S7 – Oscillator-2 Range:

Five positions – calibrate on test



Front panel layout of sockets, switches variable controls and display cutout on the completed Generator/Counter.

If a precision reference source is available, variable capacitor C1 can be adjusted until the output at socket SK3 is precisely 1Hz. Alternatively, assuming that the 10MHz source is exact, this could be used as the reference, plugging SK5 into SK1 and adjusting C1 until the display reading is exactly 10MHz. However, even though the 10MHz crystal is likely to be more accurate than the 32768Hz crystal, it too may not be absolutely perfect.

IN USE

control are run from the same power source, an inherent ground (0V) connection between them will already exist. In this case, an additional common connection via socket SK13 will not normally be needed. It will be needed, though, if a common ground connection does not exist.

So far, the need to use screened interconnections between the unit and other circuits has *not* been found necessary, although it is acknowledged that some sensitive circuits might require screened coupling.

Note that the inputs via sockets SK1 and SK2 are unprotected. This means that if you are careless, damaging signal levels could erroneously reach i.c.s that are powered at 5V. If you feel prone to this error, insert a one kilohm (1k) resistor

For reasons unknown, when first switched on, it takes several seconds for the l.c.d. to display all eight digits, during which time some may appear blank. A summary of the socket and switch functions is given in Table 1 and Table 2.

This Ultra-Fast Frequency Generator/Counter has been in use for nearly two years and has proved to be of great benefit. Occasionally it is regretted that a "triangle" wave facility was not included in the unit.

This would have complicated the design considerably, requiring far more use of analogue circuits. As it is, all frequencies are digitally generated and analogue circuitry is kept to a simple minimum.

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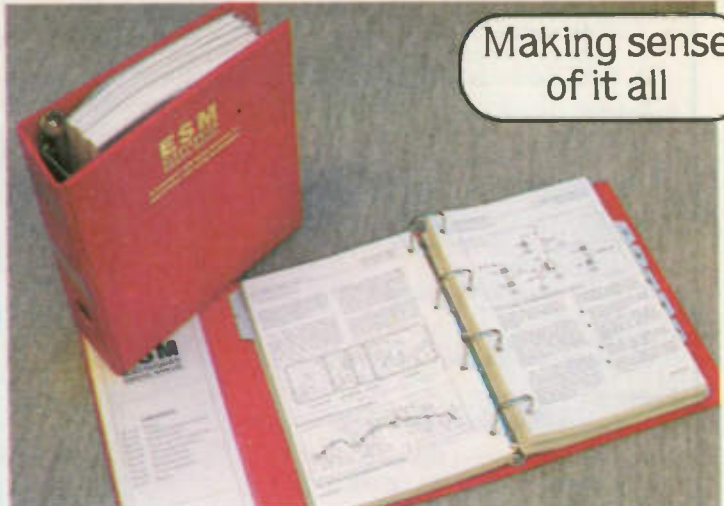
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TESTING, THEORY, DATA AND REFERENCE

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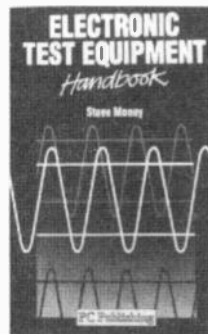
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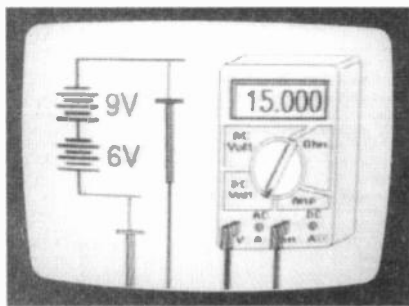
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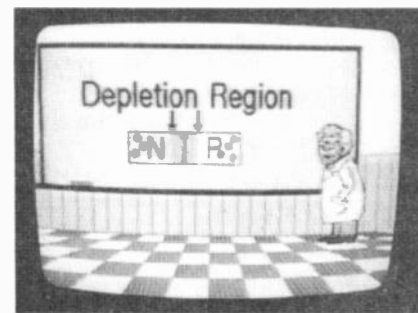
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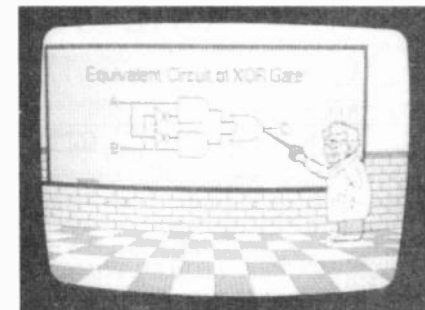
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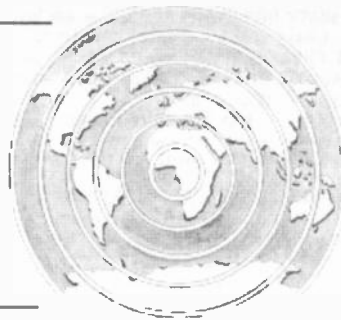
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REPORTING AMATEUR RADIO

Tony Smith G4FAI



US HAM ON MIR

There was considerable disappointment when the space shuttle *Atlantis* (STS-76) was unable to include its planned SAREX (Space Shuttle Amateur Radio Experiment) contacts with a number of school groups during its mission in March. This was due to the unexpected curtailment of the flight by one day. It is hoped to reschedule the contacts to a future flight.

SAREX is a secondary payload on many shuttle missions. It provides schools and amateur radio operators with an opportunity to talk to astronauts when they are in orbit, and many of the astronauts hold amateur radio licences for this purpose.

There will be further opportunities for amateur contacts with the shuttles during more SAREX flights planned for the rest of 1996. These are:

Columbia/STS-78/LMS, June 27, duration 16 days, with five amateur radio licensees among the crew; *Atlantis STS-79/MIR Docking Flt-4*, August 1, duration 9 days, with two amateur licensees aboard; *Columbia/STS-80*, 7th November, 16 days, with two licensees; and *Atlantis STS-81/MIR Docking Flt-5*, December 5, duration 9 days, crew to be announced.

Astronaut Shannon Lucid was transferred from *Atlantis* to *MIR* during the STS-76 mission and will be on the Russian craft until August. During her stay she will be using *MIR*'s radio from time to time to operate on 145.55MHz simplex in the amateur 2-metre band, using the callsign R0MIR.

OPERATING MANUAL

The Radio Society of Great Britain has recently published the fourth edition of its *Amateur Radio Operating Manual*. The last edition was published some ten years ago but amateur radio has advanced quite considerably since then. The new edition reflects these advances and includes coverage for the first time of microwave DXing, moonbounce, 2-metres foxhunting, digital communications and fast-scan TV.

The chapter headings give some idea of the coverage: The Amateur Service; Setting up a station; Operating practices and procedures; DX; Contests; Mobile and portable operation; Amateur satellite and space communications; Data communications; Image techniques; and Special event stations.

Add to that twelve appendices which include maps, international callsigns, the DXCC countries list, amateur frequency allocations, band plans, beacons, repeaters, packet mailboxes and nodes, etc, and the result is a book that should be in the shack of anyone interested in amateur radio.

If you want to know how to keep up with the news of DX activity; the agreed procedures for moonbounce operating; the best way to run a contest station; information on operating maritime mobile; how to say "I will send you my QSL card via the bureau" in French, German, Italian or Spanish; the answers are all here.

My own well-thumbed copy of the previous edition has been in constant use over the last ten years, and I have found it invaluable. I have no doubt this new expanded edition will serve me equally well.

The price for members is £9.90 (non-members £11.65) plus postage £1.00, and the book is available from the *Radio Society of Great Britain* (Ref. EPE), *Lambda House, Cranborne Road, Potters Bar, Herts EN6 3JE*.

NOVICE EXAM HANDBOOK

A new book by Ian Poole, G3YWX, well-known to readers of *EPE*, is *The Novice Radio Amateurs Examination Handbook*. Despite its title, however, this is not intended for "stand-alone" home study leading to the Novice licence examination. The exam can only be taken after attending a short practical course (about 30 hours over 12 weeks) arranged by the RSGB.

While this book covers the basic principles needed for the exam, its purpose is principally to complement the course, "acting as a reinforcement and background to what will be learnt."

As usual, Ian covers a lot of ground in a small book. The thirteen chapters are headed: What is Amateur Radio?; Basic Concepts; Measurements; Radio Waves; Aerials; Radio Transmissions; Receivers; Transmitters; Interference; Operating; Station Organisation; Soldering; and Safety. There is also a Novice Course Work Check Sheet, which records progress on the course, and a short list of useful books for further reading.

The book doesn't go too deeply into any given subject, but that is intentional. What it does do is summarise many aspects of the Novice course to help provide a general understanding which in turn will help a student understand more detailed aspects when faced with them.

The book could also serve as a first introduction to amateur radio for someone completely new to the subject. It is published by Bernard Babani (publishing) Ltd, at £4.95. A natural follow-on to this would be Ian's earlier book *An Introduction to Amateur Radio*, from the same publisher. Both books are available from the *EPE Direct Book Service*.

YOUNG AMATEUR OF THE YEAR

Details of the *Young Amateur of the Year Award 1996* have been announced

by the Radiocommunications Agency. The award is open to anyone under 18 who has an interest in radio.

Applicants need not be licensed amateurs but the following areas of activity will be taken into account when assessing their applications. DIY radio construction; operation of radio; community service (assisting the disabled, emergency communications, etc); encouraging others (eg, through the Novice licence scheme); and school projects.

The first prize will be £300 cash and the runner-up will receive £50. There will be additional prizes for both winners from the radiocommunications industry, plus an invitation to visit the RA's Radio Monitoring Station at Baldock in Hertfordshire.

Further details can be obtained from the Radio Society of Great Britain, address as above, to whom nominations should be sent to arrive not later than 31 July 1996.

IT'S GOODBYE FROM ME

This is my last *Reporting Amateur Radio* column. I have been writing it for over ten years, and have enjoyed the opportunity to tell *EPE* readers about the wide range of activities open to radio amateurs, and how they too can join in this fascinating hobby.

My first column was in February 1986, when I reported that amateurs had been allocated a new frequency band at 50MHz. I have continued to report developments since then, culminating in the recent news that all of the international regulations covering amateur radio, including the controversial Morse test, are to be reviewed at the ITU's *World Radio Conference* in 1999. The outcome of this review could well result in a completely new image for the hobby in the 21st century.

It has been a pleasure working with Mike Kenward and his team over this period. They produce the best magazine in its field. Long may it continue!

Thanks - Ed.

STILL WRITING

I shall continue writing in *Morsum Magnificat*, the Morse Magazine, which I helped launch in the UK in 1986. If any of you are interested in Morse telegraphy, past, present and future, and would like to continue to read my scribbles, you can get more details from: G.C. Arnold Partners (Dept EPE), 9 Wetherby Close, Broadstone, Dorset BH18 8JB. Published bimonthly, a sample copy costs £2.20.

Amateurs using Morse end the last contact of a session on the air with the following signals. What better way is there to end this column?: "73 VA CL" (Best wishes, end of work, I am now closing down.) □

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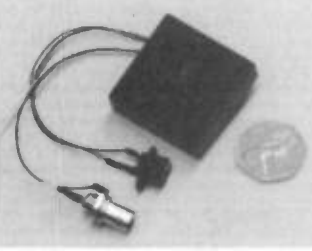
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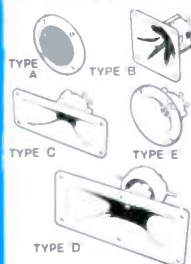
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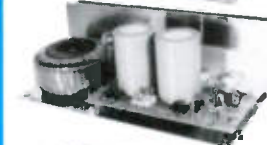
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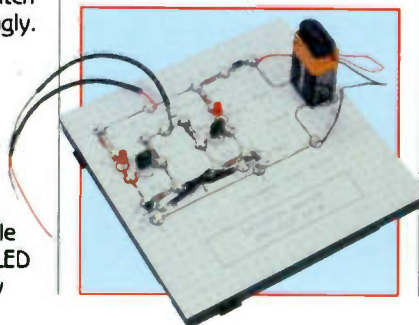
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